Impacts of Construction Activity on Yorktown Creek, Yorktown, VA

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Introduction

In early 1996, York County began preparing a site adjacent to the existing court building, located on the east bank of Yorktown Creek, in order to construct a new building and parking lots. Yorktown Creek is a small tributary of the York River arising a short distance inland of the parking lot site within the Colonial National Historic Park owned by the National Park Service (NPS). It meanders down hill crossing under US 17, thence under Rt. 238, and crosses the beach face to discharge into the York River just upstream from the Coleman Bridge connecting Yorktown and Gloucester Point. The creek lies almost totally on NPS property.

The major immediate impact that one might predict resulting from the construction activity would be an increase in turbidity followed by sedimentation at some point downstream. Indeed, sediment input was visually evident as a discoloration of the water in the creek from the start of construction. Various contaminants present on the construction or other sites along the creek might pose some risk to the creek ecosystem as sediment is carried into the stream. Prudence suggests that one should monitor polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and chlorinated pesticides, all of which may have been used or introduced onto the site previous to construction.

Once construction is completed and the ground surface covered with vegetation or an impervious surface such as a macadam parking long, turbidity would become less likely following rain events, but increases in various chemicals are likely: nutrients from fertilization of lawns, metals commonly associated with developed properties, PAH from the paving material and produced by automotive traffic on the parking areas, and various pesticides. While chlorinated pesticides are less and less used in favor of a variety of pesticides with fundamentally different chemical structure, chlorinated pesticides often continue to be observed. Thus nutrient concentrations, metals, PAH, and chlorinated hydrocarbons (including PCB, historically used pesticides, and new use materials) were included as analytes during the latter portion of the study.

Chemical analyses alone do not tell the whole story of disturbance to a habitat. The mere addition of suspended solids (expressed as turbidity) and chemicals, even at concentrations that equal or exceed accepted benchmarks for concern, is not a demonstration of impact. Therefore, the study included an evaluation of changes in the benthic community within Yorktown Creek. Since the bottom sediments are the likely final resting place for any introduced contaminants, the organisms living in closest proximity to the bottom are the ones most likely to be impacted with consequent changes in community structure and diversity. One might also examine community function, but this is another tier of observation that is costly and which may not yield any more useful information from a management perspective.

At the Yorktown Courtyard site, the landscape design causes run-off from the parking lots to pass through a small sediment retention pond before release to the creek. Various contaminants that are expected to be released from the parking lots and adjacent lawns would hopefully be captured in the retention pond. At times, however, and especially during heavy rainfall events, contaminants may pass into the creek. Thus in this study, we planned to measure the analytes both within the pond and in the creek to assess whether the pond was effective at retaining the contaminants.

There have been two prior studies in Yorktown Creek. One was a study in the early 1980s of fecal coliform concentrations at a station located near the mouth of the creek. This study was concerned with effects of a small sewage treatment plant that formerly discharged into the creek (this discharge was eliminated in 1983) (Kator, unpublished). There is some baseline information regarding polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), chlorinated pesticides, other potential contaminants, and the biota in the creek (Baker, 1995). To assess any impacts from new additions, one ideally wants some understanding of turbidity and nutrient conditions in the immediate pre-construction period. Since land clearing and site preparation had already begun at the time this study was started, no truly baseline data could be collected during this study, and none exist in the previous studies. Both sediment and nutrients (especially ammonia) were already being released into the system.

The study area extended from the Colonial Parkway Bridge near the headwater of the creek northward to Rt. US 17 and a short way on the north side of the highway, still upstream of the marshes, fresh and salt, characterizing the most downstream areas near the discharge into the York River. The portion of the creek south of US 17 is impounded by a derelict beaver dam, reaching 6-ft or so maximum depth. The impounded area is choked with emergent vegetation during the warm months of the year. Water flow appears to be very low, although no measurements of flow rate have been made.

The objective of the present study was 1) to obtain a "snapshot" of present conditions in that portion of the creek encompassing the site of interest at the earliest possible time before further construction occurred, 2) to determine immediate effects of construction including the effects of storm events during the construction phase, and 3) to monitor the creek for contaminants and general water quality after the parking lot and sediment pond are operational.

Materials and Methods

Sampling Times

Sampling Dates and Weather Conditions

Sampling occurred four times in 1996, twice in 1997 and twice in 1998. The dates and rationales are as follows:

Baseline Inventory

A single sampling was conducted on 10 April 1996 as soon as possible after funding of the project to obtain a snapshot of present conditions. Some clearing of the land and other site preparation had already been done, precluding any opportunity to obtain a true baseline data set. As will be apparent from the data, the system was not free of impact even though only land clearing and placement of sediment screens had occurred. At best, all data must be considered to represent early construction phase data. It should be noted that a significant rain had occurred about 24 hours before this sampling event.

Construction Phase

On 25 June 1996, during the construction phase, two stations were sampled, Stations 2 and 4. At this time the sediment retention pond still contained no water so the pond site could not be sampled. The initial construction phase sampling was intended to occur during a non-rainy period. The same suite of chemical and biological parameters was measured as for the initial "snapshot."

Two additional sampling trips were accomplished in 1996 with an abbreviated suite of samples, one on 12 July and the second on 8 October. These trips were deliberately conducted in association with significant rain events, i.e. when rainfall exceeded 2 inch in the 12-hour period prior to the field exercise. A simple rain gauge was attached to a post outside the NPS Police Station where it could be monitored by the NPS Natural Resource Manager or by a technician from VIMS. The rain gauge location was about 3 mile from the construction site, and therefore provides a reasonable indication of rainfall at the study site. The amount of rainfall for each event was determined from this gauge. While sampling during the first 2" of rainfall was desired, in both cases, significantly more rain had fallen overnight before we could deploy: 1.25" before the first sampling, and 2.15" before the second sampling (with an additional 2.35" falling during the period of sampling, approximately two hours). The parameters measured included temperature, conductivity, dissolved oxygen, pH, and turbidity. Turbidity was the parameter most likely to be affected by excess runoff during and immediately following these rainfall events.

A final construction phase sampling occurred on 10 April 1997. At this time, most exterior construction of the building was completed, but the parking lots still required final grading and paving. The parking lots were used by persons entering the existing courthouse or working on the site as well as by vehicles delivering construction materials. There was no rainfall during this sampling time. Two sampling stations were relocated starting with this sampling event and two new stations were added (see *Sampling Locations and Design* below).

Post-construction Sampling

Three post-construction phase sampling events were accomplished. The first was on 16 October 1997. New stations were added to the sampling design at this point (see below). Station 1 (=B) was not sampled for the full suite of parameters. The second and third post-construction phase sampling events occurred on 13 April 1998 and 7 October 1998.

Note that the October 1996 sampling event was deliberately associated with a rain event, whereas in 1997 and 1998, no sampling events were scheduled during rain events, including the October sampling events. This change in sampling design reflects the reduced amount of exterior construction activity and the desire to capture instead information concerning seasonal changes in the creek. It is mere coincidence that 1997 was a year of limited rainfall and 1998 was a year of drought which would have made a rain event sampling based on the previously used criterion difficult or impossible in any case.

Sampling Locations and Design

The initial study plan called for four stations, one upstream of the planned stormwater discharge point (Station 1), one near the planned outfall (Station 2), one downstream of the outfall and the highway that crosses the creek a few hundred feet below the outfall (Station 4), and one in the storm water retention pond (Station 3) being established adjacent to the construction site. The pond was intended to provide some level of treatment to parking lot runoff following completion of the project. During the first two sampling events, the retention pond did not contain water. Only soil was collected from this site for grain size analysis. A full suite of water and sediment samples was collected at subsequent sampling times for hydrographic, conventional water quality, and chemical contaminant analyses.

It was obvious from preliminary reconnaissance observations that turbidity was likely to be a major parameter of interest, and that the distribution of turbidity effects would be important information. To capture this information, additional stations were established at which to measure turbidity only. A total of 12 stations were selected (including stations 1-4) and identified by letter as B through M. Station A, selected as a GPS reference site, was on the Colonial Parkway bridge over the creek and was not a sampling point for turbidity. As it turned out, Station K, located at what was thought initially to be a principle culvert by which water drained from US17, was never observed to have water during 1996. Both stations were relocated in 1997 and following. Station A= was relocated to a point below the bridge. Station K= was relocated to the mouth of the main culvert through which water from Yorktown creek passes under US17.

Following the unanticipated observation of elevated PCB concentrations at the upstream location (station 1) during 1996, two additional stations were selected, one upstream of station A to the south of the Parkway bridge (A1) and one upstream in the first ravine on the east bank north of the Parkway bridge (A2). The latter site was near the now closed Yorktown Sewage Treatment Plant property. That property is now occupied by a sewage pump station pushing Yorktown waste into the Hampton Roads Sanitation District system.

Thus in 1997 and 1998, 15 stations were occupied for turbidity measurements. Hydrographic measurements of opportunity were made in the spring of 1997 and the fall of 1998 at stations A1 and A2.

Analytical methods

During each sampling event, water temperature, pH, and conductivity, were measured with a YSI Model 33, S-C-T Meter at Stations 1 (spring samples only), 2, 3 (after the pond filled) and 4. Dissolved oxygen was measured with a YSI Model 57 Oxygen Meter. In addition, turbidity was measured with a Hach 2100P Turbidimeter at a series of stations depicted in Figure 1 to gain insight into the distribution of turbidity within the creek. We had discussed placing a Datasond III or equivalent at one site to monitor the time course of turbidity input, but decided against that since there was no single site that would clearly represent sediment input into the system. In addition, though the location is patrolled by the Park Service Police, we were concerned about security of the instrument.

At the four primary sampling sites, water samples were collected from below the water surface for analysis of ammonia nitrogen, nitrite-nitrate nitrogen, total Kjeldahl nitrogen, orthophosphate, total phosphate, alkalinity, chloride, sulfate, total dissolved solids and total suspended solids. Care was taken to avoid including bottom sediment and algal matt in the samples. Sulfate, chloride, total Kjeldahl nitrogen, total dissolved solids, and alkalinity were sampled only during 1996. In 1996, sediment samples were collected from Stations 1, 2, and 4 for grain size analysis, trace element analysis and additional sediment samples for PCB and PAH measurements. Soil samples were collected from the pond site, Station 3, for grain size analysis and trace element analysis. Thereafter, samples were also collected at new stations, A1 and A2 and Station 3, now under water, for PCB and PAH analyses.

Finally, five replicate 2" diameter cores of sediment were collected at Stations 1, 2 and 4 by hand coring and preserved in formalin containing Rose Bengal stain. These samples were examined to characterize the benthic invertebrate community.

All water samples were analyzed for nutrients by the VIMS Analytical Services Center. The methods used were described in EPA document # CBP/TRS 148/96, EPA 903-R-96-006 RECOMMENDED Guidelines for the Sampling and Analyses in the Chesapeake Bay Monitoring Program. Chloride, sulfate, total Kjeldahl nitrogen and total phosphorous were measured following the procedures in EPA-600/4-79-020 A Methods for Chemical Analysis of Water and Wastewater.

Sediment samples collected for trace element analysis were extracted with 2N HCl (30 ml for 10 g sediment) and the supernatant analyzed with an ICP. Twelve analytes are initially selected: As, Ca, Cd, Cr, Cu, Fe, Hg, Mg, Ni, Pb, Se, and Zn. In 1997, the analyte list was reduced to eliminate Ca, Fe, Mg, and Hg. In the case of the first three, all are abundant naturally occurring elements and provided little useful information to the study. Mercury was eliminated because it could not be reliably reported with the analytical method used.

Aliquots of supernatant analyzed for Ca, Mg, and Fe were first diluted 1:100. All other elements were measured using the standard addition method. The ICP method is not the preferred method for analysis of Hg (the ICP detection limit for Hg (= 100 ppb) is rather high), but the data were included for the 1996 samples since no extra cost was incurred.   The ICP analyzes were performed by Ms Kea Duckenfield (1996), David Powell (1997) and Ms Christine Conrad (1998) in the laboratory of Dr. Catherine Chisholme-Brause.

Additional sediment samples were analyzed for PAH and PCB + chlorinated pesticides. The analytes were extracted from the sediment matrix using a supercritical fluid extractor (SFE) which results in similar recoveries for PCB and PAH to those obtained by Sohxlet extraction (Hale and Gaylor, 1995; Hale et al., 1996; Hale and Smith, 1996), but with substantially less production of hazardous waste. The PAH analysis was done by technicians in the laboratory of Dr. Robert Hale using the GC method described in Bieri et al. (1986) and Hale (1994). This method measures concentrations in the parts per billion range for PAH including the alkylated forms referred to as expanded PAH. Identifications were made by computer analysis of the output signal from the GC using a library of retention times. When appropriate, confirmation of identifications was obtained using GC/MS techniques. PCB + chlorinated pesticides were analyzed on a GC outfitted with an ECD using the same extract as for the PAH analysis. This method has been used extensively by Dr. Robert Hale of the VIMS environmental chemistry laboratory.

The sediment samples collected for analysis of biota were subsequently washed free of formalin. The stained animals were hand picked under a microscope and preserved in alcohol. The animals were identified to the lowest taxonomic level practicable for the groups found and enumerated by Ms Robin Draheim and Dr. Robert Diaz.

Results

Sampling Dates and Weather Conditions

As noted above, sampling occurred four times in 1996, twice in 1997 and twice in 1998. The initial sampling event on April 10 1996 was during a dry period. A second dry-period sampling was accomplished on 25 June 1996. The remaining sampling events in 1996, deliberately triggered by rain events with greater than 0.5 inches of rain, occurred on 12 July and 8 October 1996. All sampling events in 1997 and 1998 were dry period sampling events.

Though most sampling events were not triggered by rain events and we did not generate a continuous rainfall record at the park, it is constructive to consider the occurrence of rain at nearby sites during the days preceding the sampling event, both from the perspective of rainfall amount and time before sampling. Continuous daily precipitation records are available at the National Climatic Data Center (NOAA) web site for the Richmond International Airport (RIC) and the Norfolk International Airport (ORD). These two sites are each somewhat remote from the study site (29 miles away for ORD and 50 miles away for RIC). Two other sites are less remote: Langley Air Force Base (14 miles away for LAFB) and Newport News International Airport (8 miles away for PHA). These sites yielded incomplete records including during the periods of interest. Data from other nearby sites was examined to supplement data from the four sites listed above.

Based on these precipitation records, there was significant rainfall on the day preceding April 10, 1996 and two days preceding October 7, 1998, both dry-period sampling events. For all other sampling events, there had been no rain for the preceding three to 16 days. The April 1996 data in particular should be viewed with a consideration of the recent significant rain event.

Hydrographic parameters

Water temperatures were typical of the season throughout the study (Table 1). April temperatures ranged from a low of 9 C in 1996 to a high of 18 C in 1997, excluding the pond data for 1998 (22.5 C). Fall temperatures in 1996 and 1997 ranged from 15.5 to 17 C but higher in 1998 (18-21 C). The water was fresh (<0.5 psu) at all stations throughout the study and conductivity was consistently in the 250 to 400 µmhos range except in the storm water retention pond where conductivity ranged from 38 to 219 µmhos with no clear temporal pattern. pH was in the range of 6.8 to 8.1 (average 7.3) in the creek, but somewhat higher in the retention pond (7.1 to 9.3, average 8.0). pH in the retention pond declined from 1996 to 1998 and in fall of 1998 was within the range for all creek stations. Dissolved oxygen concentrations were generally higher in April than October in each year, and were especially depressed during the summer of 1996. Extremely low oxygen concentrations (<1 mg/l) were observed at stations 1 and 2 in October 1997 and station 2 in October 1998.

The parameter that showed the greatest change related to construction was turbidity. In the dry period sampling times, turbidity was low (1 to 2.27 NTU) at all stations except I (adjacent to a steep embankment north of the retention pond discharge) and L (north of US17) (Table 2). During rain events in 1996, turbidity became extremely elevated in the retention pond (>621 NTU) and was elevated in the creek as well (2.8 to 1000 NTU), with the highest turbidity during each rain event observed at stations I and L (July 1996) or D (October 1996). Observation between sampling events in 1996 revealed that the turbidity remained high throughout the year, a condition not observed in subsequent years. The retention pond had moderately high turbidity (13.1 to 19.4 NTU) in 1997 and progressively lower turbidity in 1998 (6.7 and 2.5 NTU respectively in April and October). In the creek, turbidity was generally low in both years, though isolated occurrences of elevated turbidity (10 to 20 NTU) were observed each time, most often in October and at stations A2 and I.

Conventional water quality (including nutrients)

Ten conventional water quality parameters were measured in 1996 (Table 3). In 1997 and 1998, these were reduced to five, with ammonia, nitrite-nitrate, orthophosphate, total phosphate, and total suspended solids measurements retained. Sulfate, chloride, TKN, total dissolved solids and alkalinity were within the ranges one would expect, with most parameters being slightly elevated at station 4, which is consistent with its downstream location at or near the head of the tidal marsh fringing the mouth of the creek where it enters the York River, an area that may experience periodic elevation of salinity.

The parameters measured throughout the study did not evidence any changes that can be clearly related to the construction event or subsequent parking lot run-off. Ammonia concentrations were low at the upstream stations (<0.001 to 0.059 (0.147) mg/l) with no clear pattern. At station 4, the ammonia concentration was higher ((0.014-0.075) 0.136 to 0.686 mg/l) than upstream consistent with its location near the head of the tidal marsh. Ammonia concentration in the retention pond was low throughout the study (0.010 to 0.028 mg/l). Nitrite-nitrate concentrations were also low, with little or no elevation at station 4 relative to stations 1 and 2. In April 1997, a slight elevation in nitrite-nitrate concentrations was observed in the retention pond and at station 4. Orthophosphate concentrations were consistently low (0.001-0.027 mg/l) across all stations throughout the study. During most of the study total phosphorus was low, but did increase at stations 1 and 2 in October 1998. Total phosphate in the retention pond was somewhat higher than elsewhere in October 1997 and April 1998. In general, total phosphate concentrations were higher at station 4 than anywhere else including the retention pond, suggesting that input from the pond was not the explanation. Total suspended solids were generally low at stations 1 and 2 except in October 1998. The sediment retention pond had higher total suspended solids than either station 1 or 2 in 1997, and comparable or lower total suspended solids in 1998. Station 4 had generally higher and variable total suspended solids (11 to 334 mg/l).

Thus at least in the short term following completion of the construction activity, there was no evidence of nutrient inputs to the creek through the retention pond. The pond did show somewhat elevated ammonia, orthophosphate, total phosphate, and initially, total suspended solids, but not sufficient to explain the concentrations of these parameters at station 4, especially with no elevation at station 2 nearest the pond discharge.

Sediment characteristics

The sand/silt/clay composition of the sediments at each site differed from year to year (Table 4). These differences are believed to reflect differences in precise location of the stations from year to year and the natural heterogeneity of bed material. In an anecdotal sense, this interpretation is supported by comments of the field team with regard to the difficulty of retaining material in the sampling devise. All sites were predominantly silt/clay in nature. On a few occasions, up to 55% sand was observed and in one sample up to 67% sand at the creek stations. The retention pond had a high sand content (63%) before filling with water, but in 1997 and 1998 the pond yielded a silt/clay material much like the creek bottom.

In the fall of 1998, we also measured total organic carbon and percent water in the sediment. Station 1 had the highest TOC followed by station 4. Percent water was relatively high at the creek stations (close to 90%). In contrast, the retention pond had low TOC (about 1/10 that in the creek) and lower percent water (60%). These differences are consistent the newness of the retention pond.

Metals Concentrations in Sediment

The detection limits for several metals were in many cases quite high reflecting small sample size. When quantification was possible, the values for arsenic ranged between 2.8 and 8.4 mg/kg, for cadmium between 0.2 and 2.8 mg/kg, for chromium between 2.0 and 21.7 mg/kg, for copper between 1.3 and 77.8 mg/kg, for nickel between 0.6 and 9.8 mg/kg, for lead between 2.9 and 74.7 mg/kg, for selenium between 2.4 and 16.1 mg/kg, and for zing between 2.7 and 700.8 mg/kg (Table 5). Metal concentrations were generally highest at the upstream station for cadmium, copper, lead, and zinc. There seemed to be a decline in metal concentrations at station

1 during the study, but this could reflect heterogeneity of metal distribution on a scale coincident with station location variability. With the exception of zinc at stations 1 (all years) and 2 (1996), no metals appeared to occur at concentrations that would be of serious concern.

Polycyclic aromatic hydrocarbon concentrations in sediment

Polycyclic aromatic hydrocarbons (PAH) were found at all stations sampled throughout the study, both pyrogenic PAH and biogenic PAH, the latter often dominating in concentration. The dominant pyrogenic PAH found included phenanthrene, fluoranthene, pyrene, chrysene, perylene, and benzo(ghi)perylene (Table 6). While other related PAH may well have been present, high concentrations of biogenic PAH may well have masked low concentrations of such compounds as benzo(a)pyrene or benzo(e)pyrene. The analytical method used cannot be expected to recover quantitatively the low molecular weight PAH such as naphthalene or dibenzofuran, so low molecular weight PAH, which were not often observed, are not reported because of uncertainty regarding interpretation.

These six PAH were found consistently, at stations A1, A2, 1, 2, 3, and 4, but none was observed at every sampling time and station. Ignoring samples with a PAH below the detection limit and averaging over station and time, the mean concentration of phenanthrene was 153 mg/kg (38 to 396 mg/kg), fluoranthene 460 mg/kg (10 and 1840 mg/kg), pyrene 328 mg/kg (16 and 1550 mg/kg), chrysene 563 mg/kg (27 and 1810 mg/kg), perylene 376 mg/kg (24 and 1030 mg/kg), and benzo(ghi)perylene 197 mg/kg (15 to 300 mg/kg). The mean total for these 6 PAH was 1477 mg/kg (119 - 4381 mg/kg) [Note: this value is the average of the sum PAH for each station and time, and is not mathematically equivalent to the sum of averages for the individual PAH]. Despite the high variability in these six constituents over station and time, Stations 1 and 2 exhibit higher total pyrogenic PAH than the other stations most often. There does not appear to be a temporal trend, although no rigorous analysis has been made concerning trend.

Chlorinated Hydrocarbons

A high concentration of total PCB (1530 µg/kg) was observed during the first sampling period in 1996 (Table 7). Concentrations at the other stations were consistently over 2 orders of magnitude lower (<8.2 µg/kg). Because of this observation, two stations (A1 and A2) were added to the design. Throughout the study, PCB were consistently highest at station 1 followed by station A2. On three occasions, PCB was observed above 50 µg/kg at station 2. Since this was an order of magnitude higher than was observed at station 3 (the retention pond), it is reasonable that the PCB at station 2 reflects downstream movement from station 1. While the study design does not allow making any firm statements concerning the original source of PCB, there is some suggestion that it may derive from the historical STP.

Chlordanes were also found at station 1 at concentrations well above those seen elsewhere (Table 7). Like the PCB, elevated concentrations of chlordane were observed at stations A2 and 2. Unlike PCB, chlordane was observed in the pond sediments and seemingly increasing in concentration from the fall of 1997 on. The only source of chlordane to the pond is the surrounding upland.

The third class of chlorinated hydrocarbons observed was the DDT=s including DDT, DDD, and DDE (Table 7). DDE was the primary constituent, but DDT was measured in samples with the highest concentration of the total DDT family. DDT concentrations were highest at station 1, but present at all other stations much of the time, with concentrations 1 to 2 orders of magnitude lower than at station 1. As with the other chlorinated hydrocarbons, the materials seem to be centered at station 1, and with a possible historical source of the former sewage treatment plant.

The often-unreported octochlorodibenzodioxin was observed in low concentrations in most samples collected during the study (Table 7). This dioxin, a bi-product of incomplete combustion of chlorinated hydrocarbons, is of little or no toxicological significance and is found commonly in soil samples. Its presence in the creek may indicate aeolian transport or runoff from similarly contaminated upland soils.

Biological measures

Community Statistics

Biological samples collected in April 1996 from the four primary stations proved very difficult to process because of the large amounts of plant debris from which animals had to be picked. Relatively small numbers of invertebrate taxa (Table 8) were recovered at any site, which is consistent with the early season of the year at which this sampling occurred. Densities of benthic invertebrates ranged from 16578 to 52989/m^2. Shannon-Weaver Diversity Indices ranged between 0.6 and 1.0 for all replicates pooled. The most abundant taxa at Station 1 were the oligochaetes, *Dero digitata* and *Chaetogaster* sp., representing nearly 50% of the fauna. The 7 most abundant species represented 81% of the samples at this station. Overall, the fauna was dominated by oligochaetes and chironomids. At Station 2, the most abundant taxon was a harpacticoid copepod (free or encysted) representing 58% of the fauna. The 5 most abundant taxa accounted for 93% of the fauna. The difference in faunal density at Station 2 compared to Station 1 is entirely accounted for by the harpacticoid. Station 4 was dominated by a cyclopoid copepod, which represented 61% of the fauna, whereas the harpacticoid represented only 5% of the assemblage. The 5 most abundant species accounted for 93% of the fauna.

As with samples collected in April 1996, the process of removing the animals from June 1996 samples was tedious because of the large amounts of organic debris. The data for Station 2 represents 4 of 5 replicate samples, and that for Station 4 represents 2 of 5 replicate samples . The Shannon-Weaver Diversity Index at Station 2, overwhelmingly dominated by a single species, is dramatically lower than before (0.14 vs. 0.78) whereas the Margalef Species Richness is reduced to a lesser degree (3.36 vs. 4.76). At Station 2, a harpacticoid copepod dominated as in April, representing 94% of the animals collected. Aside from the harpacticoids, oligochaetes and chironomids were present. The number of animals observed at Station 4 with only two replicates analyzed is too low to comment on except to reiterate that this station was subsequently relocated to a location more consistently submersed.

Based on five replicate benthic samples taken at stations 1, 2, 3, and 4 in April 1997, there were 3 to 15 species represented with a total of 29 to 470 specimens . The estimated population density was highest at Station 4 (about 46,378 individuals per m^2). Samples from all stations were dominated by insects (largely chironomids) followed by annelids. At station 2 the single most abundant taxon was harpacticoid copepods, reflecting its high numbers in a single replicate. The Shannon-Weaver Diversity Index was highest at Station 1 (0.6) and lowest at stations 2 and 4 (0.03).

In the fall 1997 samples, the number of taxa collected ranged from 3 to 16 with 8 to 216 individuals per station. The density of the benthic fauna was reduced by about half compared to the spring except in the sedimentation pond where it actually increased. Stations 2 and 4 were dominated by annelid worms followed by insects, whereas in the sedimentation pond, the dominant species were insects, though one annelid species had become well established. The Shannon-Weaver Diversity Indices ranged between 0.4 and 0.9.

During the fall sampling, evidence of renewed beaver activity was noted. Near the Parkway Bridge was a recently downed tree, and near Station 2, evidence of a new lodge (about 1 m in diameter and 0.5 m high). By the spring of 1998, however, the beaver had departed without having improved the dam.

The April 1998 samples from the creek had a low number of taxa (6 or 7) and low numbers of individuals (94 to 785 individuals), but animal density (number/m^2) was high (9276 to 77461/m^2). In the pond, the total number of taxa was double that at any creek station (14) but the number of individuals was intermediate (295 individuals) for an intermediate density of 29109/m^2. The diversity index during April ranged from 0.028 to 0.999 at the four stations. The diversity index in the creek during October 1997 was higher by an order of magnitude than in April of that year, whereas in the pond, the index was increased by less than 2-fold. Species richness showed much less range making trends difficult to follow. Stations 1 and 2 were dominated by harpacticoid copepods followed by insects.

Discussion

Observed Impacts

The only impact discernable during 1996 was the substantial increase in turbidity of the water, most notably in the vicinity of an arm of the creek extending northward along the northwestern edge of the Courthouse property toward US17. While one cannot be certain of the origin of the turbidity since there was construction both on the Courthouse site and US17, there was clear visual evidence of runoff over the sediment fences on the Courthouse property and on the steep embankment leading down to the creek. Further, when the highest turbidity was observed in October, the US17 site work had been completed and the soil seemingly stabilized. Thus some if not most of the turbidity is believed to derive from the courthouse site throughout 1996. This region of the study site had consistently high turbidity on every sampling visit and was visibly turbid whenever we drove by (during the early part of the study period, MHR commuted to Richmond daily and therefore had frequent opportunity to observe the site. Drive-by=s occurred at about weekly intervals thereafter coincident with other local travel.).

Turbidity throughout the ponded area increased between April and June, a time during which construction activity increased rapidly. However, this observation is curious since there was no recorded rainfall during the 11 days before the June sampling event. Despite the slow rate of water movement downstream, high turbidity resulting from a rain event that long preceded a sampling event should have declined either by downstream movement or settlement. It may be that a highly localized rain event occurred resulting in elevated turbidity, but that is speculation.

There was no evident impact of activities on the courthouse property within the creek during 1997 except possibly the elevated turbidity in the vicinity of Station I located along the western edge of the property. Again, one cannot distinguish runoff from the courthouse property from that coming from US 17 which also borders this station. The observed recovery of vegetation at the construction site and completion of parking lot containment suggests that the courthouse site may not be the source of turbidity, but this cannot be proven.

Clearly the sedimentation pond is receiving substantial amounts of sediment. This sediment is likely coming from several sources, notably the landscape adjacent to the buildings and the parking lot drainage. Nevertheless, there is no evidence that the sediment is escaping the pond into the creek at this time, though no rain event samples were collected to confirm this speculation.

The only other observable feature of concern in the system was the elevated concentrations of several metals and chlorinated hydrocarbons at station 1 and polycyclic aromatic hydrocarbons at stations 1 and 2. By themselves, these data do not demonstrate a biological impact. We therefore took several approaches to evaluating impact: comparison to background data reported in 1995 by Baker Environmental for nearby freshwater streams and chemical benchmarks for sediments reported in the literature.

The chemical data collected in this study were compared to data collected in the same general area and habitat type by Baker Environmental, Inc. as baseline data for industrialized sites on the Naval Weapons Station Yorktown (Baker, 1995). Baker sampled four freshwater creeks on National Park Service property, including one sample from the pond on Yorktown Creek, presumed to be in the same general area as station A or A1 of the present study. The four other Baker study sites were in another branch of Yorktown Creek crossed by the Colonial Parkway, Beaver Dam Creek, Great Run and Baptist Run. The lead concentrations at station 1 were high relative to all observations of Baker (1995) except for that at the Yorktown Creek pond station. The copper and zinc concentrations at station 1 exceeded the highest concentrations reported by Baker (1995) at the baseline stations. This suggests that these values might be of some concern.

Chemical benchmarks

Commonly used benchmarks for metals in sediments are the effects range low (ERL) and effects range medium (ERM) (Long and Morgan, 1990; Long et al., 1995) and the threshold effect level (TEL) and probable effect level (PEL) (MacDonald, 1994; Smith et al. 1996). These benchmarks, intended originally for evaluating marine and estuarine sediments, were developed using a mixture of estuarine and marine effects data from a wide variety of sources. While the best available data were compiled and used to develop the benchmarks, the confidence in these data varies and their application to freshwater systems could be questioned. As a result, Ingersoll et al. (1996) derived an alternative set of ERL, ERM, TEL and PEL values based exclusively on freshwater data collected by a single laboratory which removes some of the questions regarding confidence in the data underlying the derived sediment effect concentrations. Both sets of ERL, ERM, TEL and PEL values were added to the data tables for the present study.

The zinc concentration at stations 1 and 2 during April 1996 were above the ERM and PEL for zinc suggesting a fairly high probability of biological effect. This was the only zinc exceedance at station 2, but the April 1997 measurement at station 1 also equaled or exceeded the ERM and PEL. Exceedances of the ERL and TEL were also observed at station 1 for lead (April 1996 and 1997), copper (April 1996) and cadmium (April 1997), and at station 2 for cadmium (October 1997). The Baker (1995) data for the Yorktown Creek pond showed an exceedance of the ERL for cadmium and the ERM for lead.

Benchmark values for PAH have not been derived for all chemical compounds measured in the present study. Long et al. 1995 provided ERL and ERM benchmarks for phenanthrene, fluoranthene, pyrene, and chrysene. Ingersoll et al. (1996) included benzo(ghi)perylene among the PAH for which they derived benchmarks for freshwater systems. Smith et al. 1996 provided a PEL and TEL for only phenanthrene, fluoranthene, and pyrene, whereas Ingersoll et al. (1996) provided a PEL and TEL for all the PAH of concern here except perylene. Benchmarks for the total of the 5 PAH for which there are individual benchmarks were calculated as the sum of the individual benchmarks. It should be noted, however, that the individual benchmarks are not truly additive in this fashion. In addition, one should note that for the PAH, the Ingersoll et al. (1996) values are consistently lower by an order of magnitude than those of Long et al. (1995) and Smith et al. (1996). There is no information available that allows one to explain the apparent greater sensitivity of the Ingersoll et al. (1996) values.

Using the Ingersoll et al. (1996) benchmark values for the PAH, all but 4 samples exceeded the ERL and TEL, and many concentrations for each individual PAH exceeded the ERM or PEL. The picture is not as serious using the Long et al. (1995) and Smith et al. (1996) values, perhaps, but the Ingersoll et al. (1996) values are arguably more appropriate to the present situation.

Clearly, the exceedances are more common at station 1 and 2 than elsewhere. Exceedances at station 2 predate the construction activity for the Yorktown Courthouse, and therefore are likely attributable to some other source. Since the concentrations are not particularly elevated at station A1 or A2, one can speculate that the high concentrations at Stations 1 and 2 derive from the Colonial Parkway and associated vehicular traffic. While the sediment retention pond had no PAH when first dug, the sum of the five PAH found in 1997 and 1998 exceeds the ERL and TEL., though not the ERM and PEL. The concentrations in pond sediments have rapidly increased to a level comparable to or exceeding that at stations A1, A2, and 4. One cannot distinguish between stormwater inputs from an upland source and possible atmospheric inputs, but the important point is that in the short year and a half after digging the pond to expose uncontaminated subsoil, substantial concentrations of PAH now exist in these sediments.

Biota Impacts

Despite the above interpretation of the analytical data in the context of accepted benchmarks, there is no clear evidence of impacts on the benthic invertebrate community. On the one hand, species diversity and richness were consistent with the habitat being a eutrophic freshwater environment with a fine particle substrate. The dominance of annelids and opportunistic insects is not unexpected.

On the other hand, the depauperate amphipod fauna is suspicious. The absence of amphipods in the Baker (1995) study at a nearby site is consistent with our observations. Baker (1995) did, however, observe gammarid amphipods as one of the dominant species at two locations: a station in Baptist Run and a station in the other branch of Yorktown Creek. Both of these stations had very sandy sediment that may be a preferred habitat for amphipods compared to the silt-clay sediments found in the present study site, providing a simple and plausible explanation for the difference in amphipod fauna.

Amphipods are a group that is highly sensitive to toxic chemicals and in particular metals (Anonymous, 1998). Several metals are among the chemicals that exceed benchmarks in this system, suggesting that the presence of elevated metal concentrations may be reflected in the absence of amphipods.

Acknowledgments

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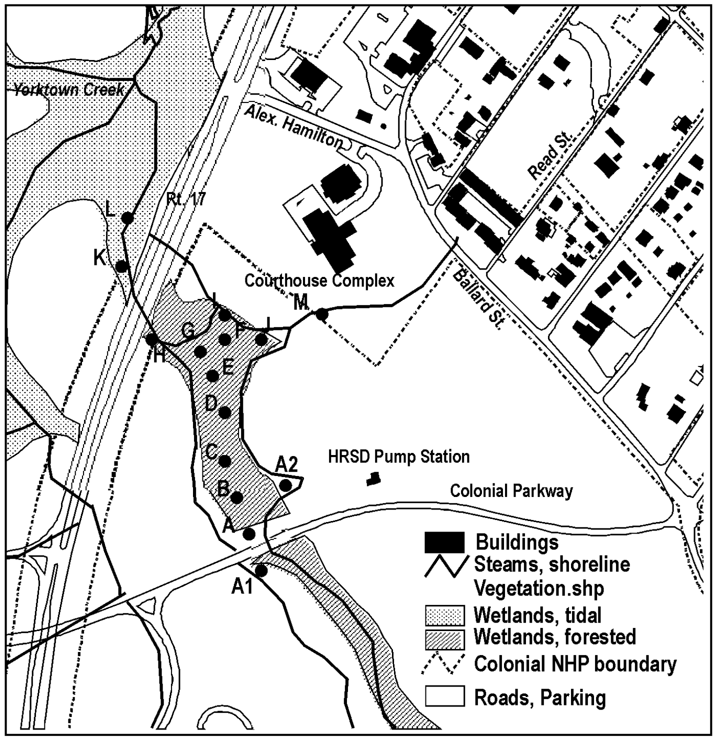

Figure 1 Map of the study portion of Yorktown Creek with turbidity sampling stations depicted. Station B corresponds to Station 1, Station F corresponds to Station 2, Station L corresponds to Station 4, and Station M corresponds to Station 3.

Parameter	Date	Stations A	A1	A2	1	2	3	4
Turbidity (NTU)	10-Apr-96				0.98	1.38	pit	15.30
	25-Jun-96					8.59	pit	1.33
	12-Jul-96				5.52	4.13	off scale	8.37
	08-Oct-96				6.07	12.20	621.00	125.00
	10-Apr-97	1.50	1.12	3.92	1.91	1.33	12.10	1.42
	16-Oct-97				3.27	3.65	19.40	1.79
	15-Apr-98	1.91	1.42	5.35	4.58	1.31	2.87	6.65
	07-Oct-98		2.08	18.10	10.90	7.31	2.50	9.87
Dissolved Oxygen (mg/l)	10-Apr-96				8.2	11.1	pit	15.2
	25-Jun-96					2.6	pit	1.4
	12-Jul-96				2.0	4.2	4.9	1.2
	08-Oct-96				1.1	1.2	6.8	5.2
	10-Apr-97	12.0	5.8	3.8	5.2	8.0	13.2	6.1
	16-Oct-97				0.4	0.7	6.3	2.0
	15-Apr-98				6.6	8.2	8.0	6.6
	07-Oct-98		3.4	18.1	10.9	0.4	6.9	2.5
Salinity (psu)	10-Apr-96				0	0	pit	0
	25-Jun-96					0	pit	0
	12-Jul-96				0	0	0	0
	08-Oct-96				0	0	0	0
	10-Apr-97		0	0	0	0	0	0
	16-Oct-97				0.3	0.2	0	0.5
	15-Apr-98				0	0	0	0

	07-Oct-98	0	0	0	0	0	0
Conductivity (µmhos)	10-Apr-96			247	236	pit	365
	25-Jun-96				400	pit	900
	12-Jul-96			363	440	180	800
	08-Oct-96			ND	ND	ND	ND
	10-Apr-97	302	275	275	265	219	600
	16-Oct-97			358	333	111	430
	15-Apr-98			339	313	38	380
	07-Oct-98	371	407	390	377	68	510
Temperature (°C)	10-Apr-96			9.0	9.5	pit	14.8
	25-Jun-96				27.0	pit	24.0
	12-Jul-96			22.2	21.0	24.0	23.0
	08-Oct-96			15.5	16.6	17.0	17.0
	10-Apr-97	12.5	11.5	12.5	14.0	17.0	18.0
	16-Oct-97			15.5	16.5	16.7	16.0
	15-Apr-98			16.0	15.0	22.5	16.0
	07-Oct-98	19.0	18.0	21.0	19.0	21.5	19.0
pH	10-Apr-96			7.74	8.11	pit	7.70
	25-Jun-96				6.80	pit	6.80
	12-Jul-96			7.02	7.17	8.05	7.00
	08-Oct-96			7.25	7.25	8.14	7.29
	10-Apr-97	7.28	7.45	7.46	7.74	9.33	7.38
	16-Oct-97			6.95	7.39	7.84	7.18
	15-Apr-98			7.32	7.60	7.34	7.47
	07-Oct-98	7.23	7.04	7.07	7.09	7.14	7.20

Turbidity (NTU)

Date	Station A1	A2	A	A'	B (=1)	C	D	E	F (=2)	G	H	I	J	K
10-Apr-96			Not available		0.98	0.89	0.90	0.82	1.38	1.66	1.46	22.30	2.27	#N/A
25-Jun-96			Not available		5.91	6.88	9.01	16.70	8.59	8.33	7.76	23.60	5.71	#N/A
12-Jul-96			Not available		5.52	2.49	37.20	10.40	4.13	7.75	4.74	23.30	5.50	#N/A
08-Oct-96			Not available		6.07	3.01	2.90	2.76	12.20	4.07	2.85	1000.00	78.40	#N/A
10-Apr-97	1.12	3.92		1.50	1.61	1.46	1.11	1.42	1.33	1.75	1.99	2.12	1.52	
16-Oct-97	1.68	19.90		1.32	3.27	1.72	1.88	1.67	3.65	2.15	2.73	13.30	3.58	
15-Apr-98	1.42	5.35		1.91	4.58	1.61	1.06	1.73	1.58	3.61	2.56	1.31	3.37	
07-Oct-98	2.08	18.10		NS	10.90	3.67	0.67	3.29	7.31	2.40	3.71	14.30	4.33	

Parameter	Date	A	A1	A2	Stations 1	2	3	4
Sulfate	10-Apr-96				4.80	5.60	pit	23.10
	25-Jun-96				nd	1.30	pit	27.60
Chloride	10-Apr-96				9.90	9.60	pit	32.60
	25-Jun-96					8.30	pit	129.00
Ammonia	10-Apr-96				nd	nd	pit	0.014
	25-Jun-96				nd	0.054	pit	0.645
	10-Apr-97				0.003	nd	0.028	0.529
	16-Oct-97				nd	0.019	0.010	0.686
	15-Apr-98				0.006	0.059	0.013	0.075
	07-Oct-98				0.147	0.010	0.019	0.136
NO2+NO3	10-Apr-96				0.002	0.002	pit	0.004
	25-Jun-96				nd	0.008	pit	0.004
	10-Apr-97				0.002	0.001	0.075	0.042
	16-Oct-97				nd	0.001	0.002	0.006

	15-Apr-98	0.001	0.001	0.004	0.003
	07-Oct-98	0.003	0.002	0.004	0.004
TKN	10-Apr-96	0.32	0.32	pit	2.02
	25-Jun-96	nd	1.11	pit	11.05
Phosphorus	10-Apr-96	0.002	0.002	pit	0.003
	25-Jun-96	nd	0.040	pit	0.004
	10-Apr-97	0.001	0.001	0.002	0.002
	16-Oct-97	nd	0.001	0.002	0.006
	15-Apr-98	0.007	0.001	0.027	0.002
	07-Oct-98	0.002	0.001	0.002	0.002
Total Phosphorus	10-Apr-96	0.034	0.032	pit	0.266
	25-Jun-96	nd	0.080	pit	1.415
	10-Apr-97	0.034	0.026	0.055	0.086
	16-Oct-97	nd	0.036	0.287	0.636
	15-Apr-98	0.025	0.028	0.119	0.043
	07-Oct-98	0.675	0.228	0.066	0.146
Total Suspended Solids	10-Apr-96	<1.3	2.2	pit	69.8
	25-Jun-96	nd	12.5	pit	333.5
	10-Apr-97	3.4	3.3	15.8	16.0
	16-Oct-97	nd	3.8	38.4	148.1
	15-Apr-98	6.5	2.0	6.3	11.3
	07-Oct-98	589.0	55.5	6.6	41.0
Total Dissolved Solids	10-Apr-96	433	428	pit	298
	25-Jun-96	nd	252	pit	719
Alkalinity	10-Apr-96	148	130.5	pit	135.5
	25-Jun-96	nd	184.8	pit	256.5

	Date	Station 1	2	3	4
Gravel	10-Apr-96	0.0	0.0	0.9	1.4
Sand		13.5	9.1	63.4	19.7
Silt		36.5	27.8	11.4	30.0
Clay		50.0	63.2	24.4	48.9
Gravel	10-Apr-97	0.0	0.0	0.0	0.0
Sand		19.9	21.2	2.0	39.7
Silt		30.5	40.4	16.1	40.9
Clay		49.6	38.4	51.9	19.5
Gravel	15-Apr-98	0.0	0.0	0.0	0.0
Sand		67.3	40.0	23.8	54.7
Silt		0.0	60.0	49.5	45.3
Clay		32.7	0.0	26.8	0.0
Gravel	07-Oct-98	0.0	0.0	0.0	0.0
Sand		52.4	25.2	9.5	48.7
Silt		41.2	62.9	53.1	33.3
Clay		6.4	12.0	67.4	18.0
TOC		415.1	124.9	13.2	182.5
% Moisture		90.8	82.9	60.0	87.5

Station	Date	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Selenium	Zinc
1	10-Apr-96	<15.0	2.8	2.0	2.0	6.2	74.7	<30.0	700.8
	25-Jun-96								
	10-Apr-97	<8.0	2.2	10.6	77.8	5.9	56.7	<15.0	403.2

	16-Oct-97								
	15-Apr-98	4.5	0.9	6.6	19.4	9.8	28.0	4.7	175.0
2	10-Apr-96	<7.0	<1.0	21.7	2.0	7.9	21.2	<14.0	614.3
	25-Jun-96	<4.5	<1.1	<2.8	<0.1	<1.0	2.9	<2.4	8.8
	10-Apr-97	<7.0	<1.0	7.2	4.7	4.8	22.9	<13.0	37.6
	16-Oct-97	<10.0	2.0	10.7	2.0	2.2	25.5	<20.0	64.1
	15-Apr-98	2.8	0.5	6.0	2.2	5.0	14.6	2.4	27.9
3	10-Apr-96	<3.0	<1.0	2.0	2.0	1.0	7.9	<6.0	2.7
	25-Jun-96								
	10-Apr-97	6.2	0.8	5.7	3.8	1.9	25.7	<8.0	27.1
	16-Oct-97	6.2	0.9	6.2	1.8	1.9	21.5	10.6	26.1
	15-Apr-98	8.7	0.5	6.0	10.6	2.8	25.7	16.1	57.6
4	10-Apr-96	8.4	1.4	9.3	2.0	0.6	22.7	<14.0	41.2
	25-Jun-96	<4.5	<1.1	<2.8	<0.1	<1.0	11.0	<2.4	8.2
	10-Apr-97	<5.0	<1.0	4.5	1.8	1.6	15.2	<9.0	12.4
	16-Oct-97	<8.0	<2.0	8.5	2.0	3.6	43.2	<16.0	55.7
	15-Apr-98	3.8	0.2	9.1	1.3	1.5	11.4	16.1	12.1
	Yorktown Creek "Pond"	3.4	2.2	23.8	6.3	13.2	381	0.44	143
	4 NPS Freshwater Creeks	0.27-5.4	% Moisture	2.8-32.8	1.0-6.3	4.6-17.5	1.8-381	0.86	3.2-143
	2 Tidal Freshwater	1.4-13.1	% Moisture	3.8-66.1	3.7-43.1	9.3-55.2	3.4-51.6	0.46-1.5	4-202

Creeks

ERL	8.2	1.2	81.0	34.0	20.9	46.7		150.0
ERM	70.0	9.6	370.0	270.0	51.6	218.0		410.0
TEL	7.2	0.7	52.3	18.7	15.9	30.2		124.0
PEL	41.6	4.2	160.4	108.2	42.8	112.2		271.0
Ingersol ERL	13.0	0.7	39.0	41.0	24.0	55.0		110.0
Ingersol ERM	50.0	3.9	270.0	190.0	45.0	99.0		550.0
Ingersol TEL	11.0	0.6	36.0	28.0	20.0	37.0		98.0
Ingersol PEL	48.0	3.2	120.0	100.0	33.0	82.0		540.0

Parameter	ERL	ERM	PEL	TEL	Date	A1	A2	1	2	3	4	
Phenanthrene					10-Apr-96			nd	nd	nd	nd	
(Long et al. 1995)	240	1500	87	544	25-Jun-96			nd	nd	nd	nd	
(Ingersoll et al. 1996)	27	350	19	410	10-Apr-97	59	38	313	396	69	55	
					16-Oct-97				nd	174	68	
					15-Apr-98	38	722	40	75	46	39	
					07-Oct-98	nd	nd	272	nd	49	nd	153.3062
Fluoranthene					10-Apr-96			1060	288	nd	nd	
(Long et al. 1995)	600	5100	113	1494	25-Jun-96				562		nd	
(Ingersoll et al. 1996)	33	180	31	320	10-Apr-97	1840	59	940	860	nd	94	
					16-Oct-97				1580	613	200	
					15-Apr-98	35	501	59	119	72	139	
					07-Oct-98	nd	10	605	313	156	24	460.45
Pyrene					10-Apr-96			1550	nd	nd	nd	
(Long et al. 1995)	665	2600	153	1398	25-Jun-96				650		nd	
(Ingersoll et al. 1996)	40	350	44	490	10-Apr-97	nd	53	528	285	nd	nd	
					16-Oct-97					658	85	

					15-Apr-98	32	598	60	67	237	66	
					07-Oct-98	nd	16	273	nd	84	nd	327.5812
Chrysene					10-Apr-96			291	nd	nd	1150	
(Long et al. 1995)	384	2800			25-Jun-96				1810		1160	
(Ingersoll et al. 1996)	30	500	27	410	10-Apr-97	514	91	177	1250	nd	376	
					16-Oct-97				1760	nd	371	
					15-Apr-98	27	194	38	nd	59	nd	
					07-Oct-98	nd	nd	157	nd	142	nd	562.7647
Perylene					10-Apr-96			1480	917	nd	nd	
(Long et al. 1995)	N/A	N/A	N/A	N/A	25-Jun-96				nd		498	
(Ingersoll et al. 1996)	N/A	N/A	N/A	N/A	10-Apr-97	578	51	1030	369	81	113	
					16-Oct-97				469	nd	nd	
					15-Apr-98	376	85	502	188	65	239	
					07-Oct-98	163	24	276	301	232	229	375.7454
Benzo(ghi)perylene					10-Apr-96			nd	nd	nd	755	
(Long et al. 1995)	N/A	N/A	N/A	N/A	25-Jun-96				293			
(Ingersoll et al. 1996)	13	280	16	250	10-Apr-97	87	nd	nd	300	nd	nd	
					16-Oct-97				nd	nd	nd	
					15-Apr-98	25	50	nd	15	32	nd	
					07-Oct-98	119	69	633	190	159	27	196.7642
Total of above PAH					10-Apr-96			#VALUE!	#VALUE!		#VALUE!	
[sum of Long et al PAH]	#VALUE!	#VALUE!	#VALUE!	#VALUE!	25-Jun-96				#VALUE!		#VALUE!	
[sum of Ingersoll et al PAH]	#VALUE!	#VALUE!	#VALUE!	#VALUE!	10-Apr-97	#VALUE!	#VALUE!	#VALUE!	3460	#VALUE!	#VALUE!	
					16-Oct-97				#VALUE!	#VALUE!	#VALUE!	

15-Apr-98	533	2150	#VALUE!	#VALUE!	511	#VALUE!		
07-Oct-98	#VALUE!	#VALUE!	2216	#VALUE!	822	#VALUE!	#VALUE!	2076.611

Parameter	ERL	ERM	TEL	PEL	Date	A1	A2	1	2	3	4
Total PCB (µg/kg dry wt)					10-Apr-96			1530.0	nd	8.2	nd
(Long et al. 1995)	22.7	180.0	21.6	188.8	25-Jun-96				124.0		8.9
(Ingersoll et al. 1996)	50.0	730.0	32.0	240.0	10-Apr-97	nd	nd	369.0	nd	nd	nd
					16-Oct-97				63.9	nd	nd
					15-Apr-98	nd	106.2	113.3	54.5	3.5	2.7
					07-Oct-98	nd	44.2	3330.0	nd	9.3	nd
Total Chlordanes (µg/kg dry wt)					10-Apr-96			722.0	nd	nd	nd
(Long et al. 1995)	0.5	6.0	2.3	4.8	25-Jun-96				2.6		nd
(Ingersoll et al. 1996)	N/A	N/A	N/A	N/A	10-Apr-97	nd	nd	85.0	nd	nd	nd
					16-Oct-97				2.3	5.6	nd
					15-Apr-98	nd	15.8	48.4	3.8	33.5	nd
					07-Oct-98	nd	4.8	940.0	nd	36.9	nd
Total DDTs (µg/kg dry wt)					10-Apr-96			554.0	nd	nd	nd
(Long et al. 1995)	1.6	46.1	1.2	4.8	25-Jun-96				19.6		nd
(Ingersoll et al. 1996)	N/A	N/A	N/A	N/A	10-Apr-97	nd	nd	72.8	nd	nd	nd
					16-Oct-97				16.2	0.1	0.5
					15-Apr-98	2.9	26.7	50.7	20.5	nd	8.6
					07-Oct-98	1.9	4.3	861.0	4.3	1.7	nd
Octochlorodibenzodioxin (µg/kg dry wt)					10-Apr-96			17.2	nd	nd	nd

(Long et al. 1995)	N/A	N/A	N/A	N/A	25-Jun-96				3.3		4.8
(Ingersoll et al. 1996)	N/A	N/A	N/A	N/A	10-Apr-97	?	?	?	?	?	?
					16-Oct-97				?	?	?
					15-Apr-98	9.4	25.7	8.8	5.0	nd	5.2
					07-Oct-98	17.0	14.9	5.6	4.1	14.0	6.5

Date	Station	1	2	3	4
10-Apr-96	Total Taxa	21	14		11
	Total Individuals	220	538		168
	Density, #/m2	21709	52989		16578
	Shannon-Weaver Diversity Index	0.999	0.776		0.579
	Margalef Species Richness	8.965	4.760		4.494
25-Jun-96					
	Total Taxa		9		4
	Total Individuals		241		4
	Density, #/m2		29726		987
	Shannon-Weaver Diversity Index		0.143		0.040
	Margalef Species Richness		3.358		4.983
10-Apr-97					
	Total Taxa	6	10	3	15
	Total Individuals	29	67	49	470
	Density, #/m2	2862	6611	4835	46378
	Shannon-Weaver Diversity Index	0.558	0.028	0.378	0.028
	Margalef Species Richness	3.419	4.929	1.183	5.239

16-Oct-97					
	Total Taxa		3	6	16
	Total Individuals		8	61	216
	Density, #/m2		789	6019	21314
	Shannon-Weaver Diversity Index		0.423	0.524	0.928
	Margalef Species Richness		2.215	2.801	6.425
09-Apr-98					
	Total Taxa	6	7	14	6
	Total Individuals	150	785	295	94
	Density, #/m2	14801	77461	29109	9276
	Shannon-Weaver Diversity Index	0.303	0.088	0.816	0.569
	Margalef Species Richness	2.298	2.073	5.264	2.534

Date	STA#	REP#	Organisms		pi=ni/N	pi log pi	Coll ID
10-Apr-96	1	1	Styleria lacustri	6	0.127659	- 0.262772	9601
10-Apr-96	1	1	Culicidae larvae	4	0.085106	- 0.209689	9601
10-Apr-96	1	1	Dero digitata	15	0.319148	- 0.364499	9601
10-Apr-96	1	1	immature tubificid w/o hair setae	1	0.021276	- 0.081918	9601
10-Apr-96	1	1	un id. Chironomid	1	0.021276	- 0.081918	9601
10-Apr-96	1	1	Chaetogaster sp.	9	0.191489	- 0.316517	9601
10-Apr-96	1	1	Chironomus sp.	3	0.063829	- 0.175629	9601

10-Apr-96	1	1	Polypedilum sp.	3	0.063829	- 0.175629	9601
10-Apr-96	1	1	Microtendipes sp.	1	0.021276	- 0.081918	9601
10-Apr-96	1	1	Tanypodinae	2	0.042553	- 0.134340	9601
10-Apr-96	1	1	Cladocera	2	0.042553	- 0.134340	9601
			No. of Taxa	11			
			No. of Specimens	47			
			Shannon-Weaver Diversity Index	2.019173			
			Margalef's Species Richness	5.980511			
10-Apr-96	1	2	Culicidae larvae	3	0.12	- 0.254431	9601
10-Apr-96	1	2	Cladocera	3	0.12	- 0.254431	9601
10-Apr-96	1	2	Chaetogaster sp.	10	0.4	- 0.366516	9601
10-Apr-96	1	2	Dero digitata	7	0.28	- 0.356430	9601
10-Apr-96	1	2	Dicrotendipes sp.	1	0.04	- 0.128755	9601
10-Apr-96	1	2	Chironomus sp.	2	0.08	- 0.202058	9601
10-Apr-96	1	2	Orthocladinae	2	0.08	- 0.202058	9601
			No. taxa	7			
			No. specimens	25			

			Shannon-Weaver Diversity Index	1.764681			
			Margalef's Species Richness	4.292029			
10-Apr-96	1	3	Dero digitata	16	0.615384	-0.298774	9601
10-Apr-96	1	3	Procladius sp.	1	0.038461	-0.125311	9601
10-Apr-96	1	3	Chironomus sp.	3	0.115384	-0.249171	9601
10-Apr-96	1	3	Polypedilum sp.	3	0.115384	-0.249171	9601
10-Apr-96	1	3	Tanypus sp.	1	0.038461	-0.125311	9601
10-Apr-96	1	3	Tanypodinae	1	0.038461	-0.125311	9601
10-Apr-96	1	3	Cyclopodia copepod	1	0.038461	-0.125311	9601
			No. taxa	7			
			No. specimens	26			
			Shannon-Weaver Diversity Index	1.298362			
			Margalef's Species Richness	4.240362			
10-Apr-96	1	4	Chaetogaster sp.	14	0.318181	-0.364360	9601
10-Apr-96	1	4	Dero digitata	12	0.272727	-0.354349	9601
10-Apr-96	1	4	Poristinella sp.	1	0.022727	-0.086004	9601
10-Apr-96	1	4	Ansioptera nymph	1	0.022727	-	9601

0.086004

10-Apr-96	1	4	Chironomus sp.	2	0.045454	-0.140501	9601
10-Apr-96	1	4	Tanypodinae	2	0.045454	-0.140501	9601
10-Apr-96	1	4	Mircotendipes sp.	1	0.022727	-0.086004	9601
10-Apr-96	1	4	Dicrotendipes sp.	1	0.022727	-0.086004	9601
10-Apr-96	1	4	Chironomini	1	0.022727	-0.086004	9601
10-Apr-96	1	4	Tanypodini	1	0.022727	-0.086004	9601
10-Apr-96	1	4	Cladocera	3	0.068181	-0.183107	9601
10-Apr-96	1	4	Cyclopodia copepods	5	0.113636	-0.247130	9601
			No. taxa	12			
			No. specimens	44			
			Shannon-Weaver Diversity Index	1.945978			
			Margalef's Species Richness	6.693225			
10-Apr-96	1	5	Culicidae larvae	5	0.066666	-0.180536	9601
10-Apr-96	1	5	Cyclopodia copepods	7	0.093333	-0.221347	9601
10-Apr-96	1	5	Cladocera	9	0.12	-0.254431	9601
10-Apr-96	1	5	Chaetogaster sp.	11	0.146666	-0.281540	9601

10-Apr-96	1	5	Dero digitata	14	0.186666	-0.313307	9601
10-Apr-96	1	5	Polypedilum sp.	9	0.12	-0.254431	9601
10-Apr-96	1	5	Procladius sp.	5	0.066666	-0.180536	9601
10-Apr-96	1	5	Chironomus sp.	3	0.04	-0.128755	9601
10-Apr-96	1	5	Tanypodinae	3	0.04	-0.128755	9601
10-Apr-96	1	5	Microtendipes sp.	7	0.093333	-0.221347	9601
10-Apr-96	1	5	un id. Chronomids	2	0.026666	-0.096649	9601
			No. taxa	11			
			No. specimens	75			
			Shannon-Weaver Diversity Index	2.261637			
			Margalef's Species Richness	5.333159			
10-Apr-96	2	1	Dero digitata	6	0.260869	-0.350539	9601
10-Apr-96	2	1	Styleria lacustri	3	0.130434	-0.265680	9601
10-Apr-96	2	1	Harpacticoid copepods	2	0.086956	-0.212378	9601
10-Apr-96	2	1	Cyclopodia copepods	2	0.086956	-0.212378	9601
10-Apr-96	2	1	Tanypodini	2	0.086956	-0.212378	9601
10-Apr-96	2	1	Chironomus sp.	1	0.043478	-	9601

						0.136325	
10-Apr-96	2	1	Cladocera	7	0.304347	- 0.362047	9601
			No. taxa	7			
			No. specimens	23			
			Shannon-Weaver Diversity Index	1.751726			
			Margalef's Species Richness	4.406166			
10-Apr-96	2	2	larval fish	1	0.005291	- 0.027734	9601
10-Apr-96	2	2	incysted Harpacticoid copepods	40	0.211640	- 0.328649	9601
10-Apr-96	2	2	Cyclopodia copepods	4	0.021164	- 0.081596	9601
10-Apr-96	2	2	Dero digitata	2	0.010582	- 0.048133	9601
10-Apr-96	2	2	immature Limnodrilus	1	0.005291	- 0.027734	9601
10-Apr-96	2	2	Chaetogaster sp.	1	0.005291	- 0.027734	9601
10-Apr-96	2	2	Chironomus sp.	1	0.005291	- 0.027734	9601
10-Apr-96	2	2	Harpacticoid copepods	128	0.677248	- 0.263935	9601
10-Apr-96	2	2	Cladocera	11	0.058201	- 0.165515	9601
			No. taxa	9			
			No. specimens	189			
			Shannon-Weaver Diversity	0.998766			

			Index				
			Margalef's Species Richness	3.514225			
10-Apr-96	2	3	Styleria lacustri	3	0.166666	-0.298626	9601
10-Apr-96	2	3	Chaetogaster sp.	3	0.166666	-0.298626	9601
10-Apr-96	2	3	Cladocera	27	1.5	0.608197	9601
10-Apr-96	2	3	incysted Harpacticoid copepod	5	0.277777	-0.355814	9601
10-Apr-96	2	3	Harpacticoid copepod	4	0.222222	-0.334239	9601
10-Apr-96	2	3	Dero digitata	5	0.277777	-0.355814	9601
10-Apr-96	2	3	Polypedilum sp.	1	0.055555	-0.160576	9601
10-Apr-96	2	3	Chironomus sp.	1	0.055555	-0.160576	9601
10-Apr-96	2	3	Cyclopodia copepods	7	0.388888	-0.367290	9601
			No. taxa	5			
			No. specimens	18			
			Shannon-Weaver Diversity Index	1.723367			
			Margalef's Species Richness	3.186559			
10-Apr-96	2	4	Chaetogaster sp.	1	0.013333	-0.057566	9601
10-Apr-96	2	4	Dero digitata	3	0.04	-0.128755	9601
10-Apr-96	2	4	Cladocera	11	0.146666	-	9601

						0.281540	
10-Apr-96	2	4	Cyclopodia copepods	18	0.24	- 0.342507	9601
10-Apr-96	2	4	Harpacticoid copepods	20	0.266666	- 0.352468	9601
10-Apr-96	2	4	incysted Harpacticoid copepods	21	0.28	- 0.356430	9601
10-Apr-96	2	4	un id. Chironomid	1	0.013333	- 0.057566	9601
			No. taxa	7			
			No. specimens	75			
			Shannon-Weaver Diversity Index	1.576834			
			Margalef's Species Richness	3.199895			
10-Apr-96	2	5	Chaetogaster sp.	2	0.010256	- 0.046972	9601
10-Apr-96	2	5	Chironomus sp.	5	0.025641	- 0.093937	9601
10-Apr-96	2	5	Tanypodini	1	0.005128	- 0.027041	9601
10-Apr-96	2	5	Polypedilum sp.	5	0.025641	- 0.093937	9601
10-Apr-96	2	5	un id. Chironomids	4	0.020512	- 0.079727	9601
10-Apr-96	2	5	Chironomus pupa	1	0.005128	- 0.027041	9601
10-Apr-96	2	5	Dero digitata	45	0.230769	- 0.338385	9601
10-Apr-96	2	5	Cladocera	20	0.102564	- 0.233565	9601

10-Apr-96	2	5	Cyclopodia copepods	18	0.092307	-0.219934	9601
10-Apr-96	2	5	incysted Harpacticoid copepods	94	0.482051	-0.351755	9601
			No. taxa	10			
			No. specimens	195			
			Shannon-Weaver Diversity Index	1.512298			
			Margalef's Species Richness	3.930071			
10-Apr-96	4	1	Styleria lacustri	4	0.2	-0.321887	9601
10-Apr-96	4	1	Dero digitata	8	0.4	-0.366516	9601
10-Apr-96	4	1	Harpacticoid copepods	8	0.4	-0.366516	9601
			No. taxa	3			
			No. specimens	20			
			Shannon-Weaver Diversity Index	1.054920			
			Margalef's Species Richness	1.537243			
10-Apr-96	4	2	Cyclopodia copepods	27	0.675	-0.265303	9601
10-Apr-96	4	2	Dero digitata	5	0.125	-0.259930	9601
10-Apr-96	4	2	Styleria lacustri	2	0.05	-0.149786	9601
10-Apr-96	4	2	Tanypus sp.	2	0.05	-0.149786	9601

10-Apr-96	4	2	Procladius sp.	1	0.025	-0.092221	9601
10-Apr-96	4	2	Polypedilum sp.	1	0.025	-0.092221	9601
10-Apr-96	4	2	Chironomus sp.	1	0.025	-0.092221	9601
10-Apr-96	4	2	un id. Chironomid	1	0.025	-0.092221	9601
			No. taxa	8			
			No. specimens	40			
			Shannon-Weaver Diversity Index	1.193695			
			Margalef's Species Richness	4.369374			
10-Apr-96	4	3	Styleria lacustri	2	0.021739	-0.083231	9601
10-Apr-96	4	3	Dero digitata	9	0.097826	-0.227403	9601
10-Apr-96	4	3	Orthocladinae pupa	1	0.010869	-0.049149	9601
10-Apr-96	4	3	Chaetogaster sp.	5	0.054347	-0.158279	9601
10-Apr-96	4	3	Cyclopodia copepods	73	0.793478	-0.183554	9601
10-Apr-96	4	3	Tanypus sp.	1	0.010869	-0.049149	9601
10-Apr-96	4	3	Chironomus sp.	1	0.010869	-0.049149	9601
			No. taxa	7			
			No. specimens	92			

			Shannon-Weaver Diversity Index	0.799918			
			Margalef's Species Richness	3.055319			
10-Apr-96	4	4	Chaetogaster sp.	1	0.25	-0.346573	9601
10-Apr-96	4	4	Harpacticoid copepod	1	0.25	-0.346573	9601
10-Apr-96	4	4	Dero digitata	2	0.5	-0.346573	9601
			No. taxa	3			
			No. specimens	4			
			Shannon-Weaver Diversity Index	1.039720			
			Margalef's Species Richness	3.321928			
10-Apr-96	4	5	Styleria lacustri	1	0.083333	-0.207075	9601
10-Apr-96	4	5	Cyclopodia copepods	3	0.25	-0.346573	9601
10-Apr-96	4	5	Dero digitata	5	0.416666	-0.364778	9601
10-Apr-96	4	5	Chaetogaster sp.	1	0.083333	-0.207075	9601
10-Apr-96	4	5	Chironomus sp.	2	0.166666	-0.298626	9601
			No. taxa	5			
			No. specimens	12			
			Shannon-Weaver Diversity Index	1.424129			

			Margalef's Species Richness	3.706513			
25-Jun-96	2	1	un id. Chironomid	1	0.03125	-0.108304	9602
25-Jun-96	2	1	Glypotendipes sp.	1	0.03125	-0.108304	9602
25-Jun-96	2	1	Cladotanytarsus sp.	1	0.03125	-0.108304	9602
25-Jun-96	2	1	incysted Harpacticoid copepods	29	0.90625	-0.089211	9602
			No. taxa	4			
			No. specimens	32			
			Shannon-Weaver Diversity Index	0.414124			
			Margalef's Species Richness	1.993156			
25-Jun-96	2	2	incysted Harpacticoid copepods	198	1	0	9602
			No. taxa	1			
			No. specimens	198			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
25-Jun-96	2	3	un id. Chironomid	1	0.142857	-0.277987	9602
25-Jun-96	2	3	Chironomus sp.	2	0.285714	-0.357932	9602
25-Jun-96	2	3	Dero digitata	2	0.285714	-0.357932	9602

25-Jun-96	2	3	Styleria lacustri	1	0.142857	-0.277987	9602
25-Jun-96	2	3	Nematode	1	0.142857	-0.277987	9602
			No. taxa	5			
			No. specimens	7			
			Shannon-Weaver Diversity Index	1.549826			
			Margalef's Species Richness	4.733178			
25-Jun-96	2	4	Polypedilum sp.	1	0.25	-0.346573	9602
25-Jun-96	2	4	Chironomus sp.	3	0.75	-0.215761	9602
			No. taxa	2			
			No. specimens	4			
			Shannon-Weaver Diversity Index	0.562335			
			Margalef's Species Richness	1.660964			
25-Jun-96	4	1	Cyclopodia copepod	1	0.333333	-0.366204	9602
25-Jun-96	4	1	Ostracod	1	0.333333	-0.366204	9602
25-Jun-96	4	1	un id. Chironomid	1	0.333333	-0.366204	9602
			No. taxa	3			
			No. specimens	3			
			Shannon-Weaver Diversity	1.098612			

			Shannon-Weaver Diversity Index				
			Margalef's Species Richness	4.191806			
25-Jun-96	4	4	Zygoptera nymph	1	1	0	9602
			No. taxa	1			
			No. specimens	1			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
10-Apr-97	1	1	Chaoborus	2	0.5	-0.346573	9701
10-Apr-97	1	1	Planorbid	2	0.5	-0.346573	9701
			No. of Taxa	1			
			No. of Specimens	4			
			Shannon-Weaver Diversity Index	0.693147			
			Margalef's Species Richness	0			
10-Apr-97	1	2	Chironomids	1	1	0	9701
			No. taxa	1			
			No. specimens	1			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
10-Apr-97	1	3					9701

			No. taxa	0			
			No. specimens	0			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	#NUM!			
10-Apr-97	1	4	Chironomids	16	0.666666	- 0.270310	9701
10-Apr-97	1	4	Coelotanypus	2	0.083333	- 0.207075	9701
10-Apr-97	1	4	Chironomus sp.	1	0.041666	- 0.132418	9701
10-Apr-97	1	4	Chaetogaster	5	0.208333	- 0.326794	9701
			No. taxa	4			
			No. specimens	24			
			Shannon-Weaver Diversity Index	0.936599			
			Margalef's Species Richness	2.173580			
10-Apr-97	1	5					9701
			No. taxa	0			
			No. specimens	0			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	#NUM!			
10-Apr-97	2	1	Chironomids	3	1	0	:: 9701

			No. taxa	1			
			No. specimens	3			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
10-Apr-97	2	2	Harpacticoids	10	0.555555	-0.326548	9701
10-Apr-97	2	2	Chironomids	2	0.111111	-0.244136	9701
10-Apr-97	2	2	Planorbid	4	0.222222	-0.334239	9701
10-Apr-97	2	2	Chaetogas	1	0.055555	-0.160576	9701
10-Apr-97	2	2	Zygopteran larva	1	0.055555	-0.160576	9701
			No. taxa	5			
			No. specimens	18			
			Shannon-Weaver Diversity Index	1.226076			
			Margalef's Species Richness	3.186559			
10-Apr-97	2	3					9701
			No. taxa	0			
			No. specimens	0			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	#NUM!			

10-Apr-97	2	4	Chaoborus	1	0.1	-0.230258	9701
10-Apr-97	2	4	Dero digitata	2	0.2	-0.321887	9701
10-Apr-97	2	4	Coelotanypus	2	0.2	-0.321887	9701
10-Apr-97	2	4	Chironomus	1	0.1	-0.230258	9701
10-Apr-97	2	4	Planorbid	3	0.3	-0.361191	9701
10-Apr-97	2	4	Zygopteran	1	0.1	-0.230258	9701
			No. taxa	12			
			No. specimens	10			
			Shannon-Weaver Diversity Index	1.695742			
			Margalef's Species Richness	11			
10-Apr-97	2	5	Chironomids	5	0.25	-0.346573	9701
10-Apr-97	2	5	Naids	1	0.05	-0.149786	9701
10-Apr-97	2	5	Chaoborus	1	0.05	-0.149786	9701
10-Apr-97	2	5	Doro digita	8	0.4	-0.366516	9701
10-Apr-97	2	5	Coelotanypus	3	0.15	-0.284567	9701
10-Apr-97	2	5	Chironomus	1	0.05	-0.149786	9701
10-Apr-97	2	5	Planorbid	1	0.05	-	

						0.149786	
			No. taxa	7			
			No. specimens	20			
			Shannon-Weaver Diversity Index	1.596804			
			Margalef's Species Richness	4.611730			
10-Apr-97	3	1	Chironomids	8	0.571428	- 0.319780	9701
10-Apr-97	3	1	Chaoborus	1	0.071428	- 0.188504	9701
10-Apr-97	3	1	Dero digitata	5	0.357142	- 0.367721	9701
			No. taxa	3			
			No. specimens	14			
			Shannon-Weaver Diversity Index	0.876005			
			Margalef's Species Richness	1.745005			
10-Apr-97	3	2	Chironomids	7	1	0	9701
			No. taxa	1			
			No. specimens	7			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
10-Apr-97	3	3	Chironomids	4	0.666666	- 0.270310	9701
10-Apr-97	3	3	Chaoborus	1	0.166666	-	9701

						0.298626	
10-Apr-97	3	3	Dero digitata	1	0.166666	-0.298626	9701
			No. taxa	3			
			No. specimens	6			
			Shannon-Weaver Diversity Index	0.867563			
			Margalef's Species Richness	2.570194			
10-Apr-97	3	4	Chironomids	7	0.7	-0.249672	9701
10-Apr-97	3	4	Chaoborus	2	0.2	-0.321887	9701
10-Apr-97	3	4	Dero digitata	1	0.1	-0.230258	9701
			No. taxa	3			
			No. specimens	10			
			Shannon-Weaver Diversity Index	0.801818			
			Margalef's Species Richness	2			
10-Apr-97	3	5	Chironomids	6	0.5	-0.346573	9701
10-Apr-97	3	5	Chaoborus	2	0.166666	-0.298626	9701
10-Apr-97	3	5	Dero digitata	4	0.333333	-0.366204	9701
			No. taxa	3			
			No. specimens	12			

			Shannon-Weaver Diversity Index	1.011404			
			Margalef's Species Richness	1.853256			
							::
10-Apr-97	4	1	Dero digitata	29	0.674418	- 0.265656	9701
10-Apr-97	4	1	Chaetogaster	4	0.093023	- 0.220921	9701
10-Apr-97	4	1	Acellus	1	0.023255	- 0.087469	9701
10-Apr-97	4	1	Physa	9	0.209302	- 0.327343	9701
			No. taxa	4			
			No. specimens	43			
			Shannon-Weaver Diversity Index	0.901391			
			Margalef's Species Richness	1.836582			
10-Apr-97	4	2	Chironomids	2	0.012987	- 0.056413	9701
10-Apr-97	4	2	Naids	89	0.577922	- 0.316884	9701
10-Apr-97	4	2	Dero digitata	4	0.025974	- 0.094822	9701
10-Apr-97	4	2	Planorbid	1	0.006493	- 0.032707	9701
10-Apr-97	4	2	Chaetogaster	27	0.175324	- 0.305260	9701
10-Apr-97	4	2	un id. Chironomid pupa	3	0.019480	- 0.076720	9701
10-Apr-97	4	2	Snail (dextro)	1	0.006493	-	9701

						0.032707	
10-Apr-97	4	2	Chaetogaster	27	0.175324	-0.305260	9701
			No. taxa	8			
			No. specimens	154			
			Shannon-Weaver Diversity Index	1.220776			
			Margalef's Species Richness	3.199969			
10-Apr-97	4	3	un id. Chironomid	1	0.030303	-0.105954	9701
10-Apr-97	4	3	Naidae	6	0.181818	-0.309954	9701
10-Apr-97	4	3	Dero digitata	5	0.151515	-0.285919	9701
10-Apr-97	4	3	Acellus	16	0.484848	-0.350990	9701
10-Apr-97	4	3	Physa	1	0.030303	-0.105954	9701
10-Apr-97	4	3	Ceratopongid	4	0.121212	-0.255783	9701
			No. taxa	6			
			No. specimens	33			
			Shannon-Weaver Diversity Index	1.414557			
			Margalef's Species Richness	3.292692			
10-Apr-97	4	4	Chironomids	4	0.021978	-0.083905	9701
10-Apr-97	4	4	Naidae	97	0.532967	-	9701

						0.335393	
10-Apr-97	4	4	Dero digitata	10	0.054945	-0.159418	9701
10-Apr-97	4	4	Chironomus	3	0.016483	-0.067671	9701
10-Apr-97	4	4	Planorbid	1	0.005494	-0.028593	9701
10-Apr-97	4	4	Acellus	40	0.219780	-0.332994	9701
10-Apr-97	4	4	Ceratopongid	24	0.131868	-0.267158	9701
10-Apr-97	4	4	Snail (dextro)	1	0.005494	-0.028593	9701
10-Apr-97	4	4	Pisidium	1	0.005494	-0.028593	9701
10-Apr-97	4	4	Limnodrilus	1	0.005494	-0.028593	9701
			No. taxa	10			
			No. specimens	182			
			Shannon-Weaver Diversity Index	1.360917			
			Margalef's Species Richness	3.982175			
10-Apr-97	4	5	Coelotanypus	21	0.362068	-0.367833	9701
10-Apr-97	4	5	Dero digitata	2	0.034482	-0.116113	9701
10-Apr-97	4	5	Chironomid	12	0.206896	-0.325973	9701
10-Apr-97	4	5	Planorbid	4	0.068965	-0.184424	9701

10-Apr-97	4	5	Acellus	1	0.017241	-0.070007	9701
10-Apr-97	4	5	Chaetogaster	4	0.068965	-0.184424	9701
10-Apr-97	4	5	Pisidium	13	0.224137	-0.335196	9701
10-Apr-97	4	5	Zygopteran	1	0.017241	-0.070007	9701
			No. taxa	8			
			No. specimens	58			
			Shannon-Weaver Diversity Index	1.653980			
			Margalef's Species Richness	3.969541			
16-Oct-97	2	1					9702
			No. taxa	0			
			No. specimens	0			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	#NUM!			
16-Oct-97	2	2	Dero digitata	1	1	0	9702
			No. taxa	1			
			No. specimens	1			
			Shannon-Weaver Diversity Index	0			
			Margalef's Species Richness	0			
16-Oct-97	2	3	Dero digitata	1	0.5	-	9702

						0.346573	
16-Oct-97	2	3	Planorbid	1	0.5	- 0.346573	9702
			No. taxa	2			
			No. specimens	2			
			Shannon-Weaver Diversity Index	0.693147			
			Margalef's Species Richness	3.321928			
16-Oct-97	2	4	Chironomid	1	0.5	- 0.346573	9702
16-Oct-97	2	4	Dero digitata	1	0.5	- 0.346573	9702
			No. taxa	2			
			No. specimens	2			
			Shannon-Weaver Diversity Index	0.693147			
			Margalef's Species Richness	3.321928			
16-Oct-97	2	5	Chironomid	2	0.666666	- 0.270310	9702
16-Oct-97	2	5	Dero digitata	1	0.333333	- 0.366204	9702
			No. taxa	2			
			No. specimens	3			
			Shannon-Weaver Diversity Index	0.636514			
			Margalef's Species Richness	2.095903			

16-Oct-97	3	1	Chironomids	6	0.272727	-0.354349	9702
16-Oct-97	3	1	Chaoborus	5	0.227272	-0.336728	9702
16-Oct-97	3	1	Dero digitata	10	0.454545	-0.358389	9702
16-Oct-97	3	1	Zygopteran larva	1	0.045454	-0.140501	9702
			No. taxa	4			
			No. specimens	22			
			Shannon-Weaver Diversity Index	1.189969			
			Margalef's Species Richness	2.234765			
16-Oct-97	3	2	Chironomids	1	0.125	-0.259930	9702
16-Oct-97	3	2	Naidae	1	0.125	-0.259930	9702
16-Oct-97	3	2	Chaoborus	6	0.75	-0.215761	9702
			No. taxa	3			
			No. specimens	8			
			Shannon-Weaver Diversity Index	0.735621			
			Margalef's Species Richness	2.214618			
16-Oct-97	3	3	Chironomids	1	0.047619	-0.144977	9702
16-Oct-97	3	2	Chironumus sp	1	0.047619	-	9702

						0.144977	
16-Oct-97	3	3	Chaoborus	16	0.761904	-0.207187	9702
16-Oct-97	3	3	Dero digitata	3	0.142857	-0.277987	9702
			No. taxa	4			
			No. specimens	21			
			Shannon-Weaver Diversity Index	0.775129			
			Margalef's Species Richness	2.268912			
16-Oct-97	3	4	Chironomids	1	0.333333	-0.366204	9702
16-Oct-97	3	4	Chaoborus	2	0.666666	-0.270310	9702
			No. taxa	2			
			No. specimens	3			
			Shannon-Weaver Diversity Index	0.636514			
			Margalef's Species Richness	2.095903			
16-Oct-97	3	5	Chironomids	2	0.285714	-0.357932	9702
16-Oct-97	3	5	Chaoborus	2	0.285714	-0.357932	9702
16-Oct-97	3	5	Dero digitata	3	0.428571	-0.363127	9702
			No. taxa	3			
			No. specimens	7			

Shannon-Weaver Diversity Index	1.078992
Margalef's Species Richness	2.366589

16-Oct-97	4	1	Chironomid	1	0.017543	-0.070930	9702
16-Oct-97	4	1	Naidae	15	0.263157	-0.351316	9702
16-Oct-97	4	1	Planorbid	9	0.157894	-0.291446	9702
16-Oct-97	4	1	Acellus	14	0.245614	-0.344840	9702
16-Oct-97	4	1	Physa	1	0.017543	-0.070930	9702
16-Oct-97	4	1	Ceratopongid	2	0.035087	-0.117540	9702
16-Oct-97	4	1	Pisidium	1	0.017543	-0.070930	9702
16-Oct-97	4	1	Triclad	11	0.192982	-0.317486	9702
16-Oct-97	4	1	Eristalis	2	0.035087	-0.117540	9702
16-Oct-97	4	1	Xygoetra	1	0.017543	-0.070930	9702

No. taxa	10
No. specimens	57
Shannon-Weaver Diversity Index	1.823893
Margalef's Species Richness	5.125650

16-Oct-97	4	2	Naids	8	0.137931	-0.273241	9702
16-Oct-97	4	2	Acellus	18	0.310344	-0.363125	9702
16-Oct-97	4	2	Ceratopongid	13	0.224137	-0.335196	9702
16-Oct-97	4	2	Pisidium	1	0.017241	-0.070007	9702
16-Oct-97	4	2	Limnodrilus	8	0.137931	-0.273241	9702
16-Oct-97	4	2	Gammarus	1	0.017241	-0.070007	9702
16-Oct-97	4	2	Triclad	2	0.034482	-0.116113	9702
16-Oct-97	4	2	Eristalis	1	0.017241	-0.070007	9702
16-Oct-97	4	2	Ilyodrilus	6	0.103448	-0.234691	9702
			No. taxa	9			
			No. specimens	58			
			Shannon-Weaver Diversity Index	1.805633			
			Margalef's Species Richness	4.536618			
16-Oct-97	4	3	Planorbid	1	0.037037	-0.122068	9702
16-Oct-97	4	3	Acellus	9	0.333333	-0.366204	9702
16-Oct-97	4	3	Physa	1	0.037037	-0.122068	9702
16-Oct-97	4	3	Limnodrilus	2	0.074074	-	9702

						0.192791	
16-Oct-97	4	3	Triclad	4	0.148148	- 0.282895	9702
16-Oct-97	4	3	Eristalis	2	0.074074	- 0.192791	9702
16-Oct-97	4	3	Ilyodrilus	3	0.111111	- 0.244136	9702
16-Oct-97	4	3	Styleria	4	0.148148	- 0.282895	9702
16-Oct-97	4	3	Xygoetra	1	0.037037	- 0.122068	9702
			No. taxa	9			
			No. specimens	27			
			Shannon-Weaver Diversity Index	1.927918			
			Margalef's Species Richness	5.589075			
							::
16-Oct-97	4	4	Chironomids	1	0.03125	- 0.108304	9702
16-Oct-97	4	4	Naidae	3	0.09375	- 0.221917	9702
16-Oct-97	4	4	Acellus	20	0.625	- 0.293752	9702
16-Oct-97	4	4	Ceratopongid	1	0.03125	- 0.108304	9702
16-Oct-97	4	4	Gammarus	1	0.03125	- 0.108304	9702
16-Oct-97	4	4	Eristalis	4	0.125	- 0.259930	9702
16-Oct-97	4	4	Ilyodrilus	1	0.03125	-	9702

						0.108304	
16-Oct-97	4	4	Xygoetra	1	0.03125	-0.108304	9702
			No. taxa	8			
			No. specimens	32			
			Shannon-Weaver Diversity Index	1.317121			
			Margalef's Species Richness	4.650699			
16-Oct-97	4	5	Naidae	6	0.142857	-0.277987	9702
16-Oct-97	4	5	Dero digitata	4	0.095238	-0.223940	9702
16-Oct-97	4	5	Acellus	21	0.5	-0.346573	9702
16-Oct-97	4	5	Physa	6	0.142857	-0.277987	9702
16-Oct-97	4	5	Pisidium	2	0.047619	-0.144977	9702
16-Oct-97	4	5	Limnodrilus	1	0.023809	-0.088992	9702
16-Oct-97	4	5	Eristalis	1	0.023809	-0.088992	9702
16-Oct-97	4	5	Gambusia	1	0.023809	-0.088992	9702
			No. taxa	8			
			No. specimens	42			
			Shannon-Weaver Diversity Index	1.538442			
			Margalef's Species Richness	4.312338			

09-Apr-98	1	1	Harpacticoids	36	0.72000	-0.23652	9801
09-Apr-98	1	1	Cyclopods	3	0.06000	-0.16880	9801
09-Apr-98	1	1	Chironomids	11	0.22000	-0.33311	9801
			No. of Taxa	3			
			No. of Specimens	50			
			Shannon-Weaver Diversity Index	0.73844			
			Margalef's Species Richness	1.17718			
09-Apr-98	1	2	Harpacticoids	25	0.89286	-0.10119	9801
09-Apr-98	1	2	Cyclopods	2	0.07143	-0.18850	9801
09-Apr-98	1	2	Tanytarsini	1	0.03571	-0.11901	9801
			No. taxa	3			
			No. specimens	28			
			Shannon-Weaver Diversity Index	0.40870			
			Margalef's Species Richness	1.38202			
09-Apr-98	1	3	Harpacticoids	13	1.00000	0.00000	9801
			No. taxa	1			
			No. specimens	13			
			Shannon-Weaver Diversity Index	0.00000			
			Margalef's Species Richness	0.00000			
09-Apr-98	1	4	Harpacticoids	36	0.76596	-0.20423	9801
09-Apr-98	1	4	Cyclopods	7	0.14894	-0.28361	9801

09-Apr-98	1	4	Chironomids	1	0.02128	-0.08192	9801
09-Apr-98	1	4	Culicid	1	0.02128	-0.08192	9801
09-Apr-98	1	4	Naidae	2	0.04255	-0.13434	9801
			No. taxa	5			
			No. specimens	47			
			Shannon-Weaver Diversity Index	0.786012			
			Margalef's Species Richness	2.392204			
09-Apr-98	1	5	Harpacticoids	12	1.00000	0.00000	9801
			No. taxa	1			
			No. specimens	12			
			Shannon-Weaver Diversity Index	0.00000			
			Margalef's Species Richness	0.00000			
							::
09-Apr-98	2	1	Harpacticoids	256	0.99225	-0.00772	9801
09-Apr-98	2	1	Chironomids	2	0.00775	-0.03767	9801
			No. taxa	2			
			No. specimens	258			
			Shannon-Weaver Diversity Index	0.045394			
			Margalef's Species Richness	0.414659			
09-Apr-98	2	2	Harpacticoids	34	0.79070	-0.18569	9801
09-Apr-98	2	2	Chironomids	5	0.11628	-0.25020	9801
09-Apr-98	2	2	Cyclopods	2	0.04651	-0.14270	9801
09-Apr-98	2	2	Tanytarsini	2	0.04651	-0.14270	9801

			No. taxa	4			
			No. specimens	43			
			Shannon-Weaver Diversity Index	0.721292			
			Margalef's Species Richness	1.836582			
09-Apr-98	2	3	Harpacticoids	186	0.98413	-0.01575	9801
09-Apr-98	2	3	Chironomids	2	0.01058	-0.04813	9801
09-Apr-98	2	3	Ceratopongonid	1	0.00529	-0.02773	9801
			No. taxa	3			
			No. specimens	189			
			Shannon-Weaver Diversity Index	0.091613			
			Margalef's Species Richness	0.878556			
09-Apr-98	2	4	Harpacticoids	207	0.95833	-0.04079	9801
09-Apr-98	2	4	Cyclopods	2	0.00926	-0.04335	9801
09-Apr-98	2	4	Stylaria	1	0.00463	-0.02489	9801
09-Apr-98	2	4	Chironomids	4	0.01852	-0.07387	9801
09-Apr-98	2	4	Tanytarsini	2	0.00926	-0.04335	9801
			No. taxa	10			
			No. specimens	216			
			Shannon-Weaver Diversity Index	0.226248			
			Margalef's Species Richness	3.855291			
09-Apr-98	2	5	Harpacticoids	74	0.96104	-0.03819	9801
09-Apr-98	2	5	Chironomids	2	0.02597	-0.09482	9801
09-Apr-98	2	5	Nematode	1	0.01299	-0.05641	9801

			No. taxa	3			
			No. specimens	77			
			Shannon-Weaver Diversity Index	0.189427			
			Margalef's Species Richness	1.060169			
							::
09-Apr-98	3	1	Dero digitata	31	0.39241	-0.36708	9801
09-Apr-98	3	1	Naidae	19	0.24051	-0.34272	9801
09-Apr-98	3	1	Cladocera	15	0.18987	-0.31546	9801
09-Apr-98	3	1	Chironomids	6	0.07595	-0.19577	9801
09-Apr-98	3	1	Chironomus	3	0.03797	-0.12421	9801
09-Apr-98	3	1	Tanypodinid	1	0.01266	-0.05531	9801
09-Apr-98	3	1	Unidentified Invert	2	0.02532	-0.09307	9801
09-Apr-98	3	1	Snail, planorbid	2	0.02532	-0.09307	9801
			No. taxa	8			
			No. specimens	79			
			Shannon-Weaver Diversity Index	1.586692			
			Margalef's Species Richness	3.688817			
09-Apr-98	3	2	Dero sp	23	0.18254	-0.31046	9801
09-Apr-98	3	2	Naidae	47	0.37302	-0.36784	9801
09-Apr-98	3	2	Cladocera	18	0.14286	-0.27799	9801
09-Apr-98	3	2	Chironomid pupa	1	0.00794	-0.03838	9801
09-Apr-98	3	2	Chironomus	3	0.02381	-0.08899	9801
09-Apr-98	3	2	Unidentified Invert	33	0.26190	-0.35089	9801
09-Apr-98	3	2	Snail	1	0.00794	-0.03838	9801
			No. taxa	7			

			No. specimens	126			
			Shannon-Weaver Diversity Index	1.472943			
			Margalef's Species Richness	2.856638			
09-Apr-98	3	3	Dero sp	4	0.44444	-0.36041	9801
09-Apr-98	3	3	Cladocera	5	0.55556	-0.32655	9801
			No. taxa	2			
			No. specimens	9			
			Shannon-Weaver Diversity Index	0.686961			
			Margalef's Species Richness	1.047951			
09-Apr-98	3	4	Dero sp	3	0.08333	-0.20708	9801
09-Apr-98	3	4	Naidae	5	0.13889	-0.27418	9801
09-Apr-98	3	4	Cladocera	18	0.50000	-0.34657	9801
09-Apr-98	3	4	Ansiopteran nymph	1	0.02778	-0.09954	9801
09-Apr-98	3	4	Chironomus	3	0.08333	-0.20708	9801
09-Apr-98	3	4	Unidentified Invert	5	0.13889	-0.27418	9801
09-Apr-98	3	4	Snail, planorbid	1	0.02778	-0.09954	9801
			No. taxa	7			
			No. specimens	36			
			Shannon-Weaver Diversity Index	1.508164			
			Margalef's Species Richness	3.855291			
09-Apr-98	3	5	Dero sp	7	0.15556	-0.28945	9801
09-Apr-98	3	5	Naidae	4	0.08889	-0.21514	9801
09-Apr-98	3	5	Cladocera	13	0.28889	-0.35872	9801
09-Apr-98	3	5	Cyclopods	1	0.02222	-0.08459	9801

09-Apr-98	3	5	Chironomid pupa	1	0.02222	-0.08459	9801
09-Apr-98	3	5	Chironomus	2	0.04444	-0.13838	9801
09-Apr-98	3	5	Coleopteran larva	1	0.02222	-0.08459	9801
09-Apr-98	3	5	Unidentified Invert	16	0.35556	-0.36767	9801
			No. taxa	8			
			No. specimens	45			
			Shannon-Weaver Diversity Index	1.623137			
			Margalef's Species Richness	4.234180			
							::
09-Apr-98	4	1	Tubificid	1	0.07692	-0.19730	9801
09-Apr-98	4	1	Isopod	4	0.30769	-0.36266	9801
09-Apr-98	4	1	Unidentified Clam	8	0.61538	-0.29877	9801
			No. taxa	3			
			No. specimens	13			
			Shannon-Weaver Diversity Index	0.858740			
			Margalef's Species Richness	1.795423			
09-Apr-98	4	2	Dero sp	2	0.06667	-0.18054	9801
09-Apr-98	4	2	Tubificid	21	0.70000	-0.24967	9801
09-Apr-98	4	2	Isopod	5	0.16667	-0.29863	9801
09-Apr-98	4	2	Unidentified Clam	2	0.06667	-0.18054	9801
			No. taxa	4			
			No. specimens	30			
			Shannon-Weaver Diversity Index	0.909372			
			Margalef's Species Richness	2.030977			

09-Apr-98	4	3	Tubificid	17	0.85000	-0.13814	9801
09-Apr-98	4	3	Isopod	1	0.05000	-0.14979	9801
09-Apr-98	4	3	Nematode	2	0.10000	-0.23026	9801
			No. taxa	3			
			No. specimens	20			
			Shannon-Weaver Diversity Index	0.518186			
			Margalef's Species Richness	1.537243			
09-Apr-98	4	4	Tubificid	9	0.39130	-0.36715	9801
09-Apr-98	4	4	Isopod	4	0.17391	-0.30421	9801
09-Apr-98	4	4	Unidentified Insect	1	0.04348	-0.13633	9801
09-Apr-98	4	4	Unidentified Clam	8	0.34783	-0.36732	9801
09-Apr-98	4	4	Nematode	1	0.04348	-0.13633	9801
			No. taxa	5			
			No. specimens	23			
			Shannon-Weaver Diversity Index	1.311332			
			Margalef's Species Richness	2.937444			
09-Apr-98	4	5	Dero sp	4	0.50000	-0.34657	9801
09-Apr-98	4	5	Isopod	3	0.37500	-0.36781	9801
09-Apr-98	4	5	Unidentified Clam	1	0.12500	-0.25993	9801
			No. taxa	3			
			No. specimens	8			
			Shannon-Weaver Diversity Index	0.974314			
			Margalef's Species Richness	2.214618			

Date	STA#		Organisms	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Total	pi=ni/N	pi log pi	Coll ID
10-Apr-96	1	Annelida, Oligochaeta	Poristinella sp.				1		1	0.004545	-0.010647	9601
10-Apr-96	1	Annelida, Oligochaeta	Dero digitata	15	7	16	12	14	64	0.290909	-0.155998	9601
10-Apr-96	1	Annelida, Oligochaeta	imm tubificid w/o setae	1					1	0.004545	-0.010647	9601
10-Apr-96	1	Annelida, Oligochaete	Chaetogaster sp.	9	10		14	11	44	0.200000	-0.139794	9601
10-Apr-96	1	Annelida, Oligochaete	Styleria lacustri	6					6	0.027273	-0.042662	9601
10-Apr-96	1	Crustacea, Cladocera	Cladocera	2	3		3	9	17	0.077273	-0.085925	9601
10-Apr-96	1	Crustacea, Copepoda, Cyclopoida	Cyclopoid copepod			1	5	7	13	0.059091	-0.072592	9601
10-Apr-96	1	Insecta, Chironomidae	Chironomini				1		1	0.004545	-0.010647	9601
10-Apr-96	1	Insecta, Chironomidae	Chironomus sp.	3	2	3	2	3	13	0.059091	-0.072592	9601
10-Apr-96	1	Insecta, Culicidae	Culicidae larvae	4	3			5	12	0.054545	-0.068904	9601
10-Apr-96	1	Insecta, Tendipedidae	Dicrotendipes sp.		1		1		2	0.009091	-0.018558	9601
10-Apr-96	1	Insecta, Tendipedidae	Microtendipes sp.	1			1	7	9	0.040909	-0.056789	9601
10-Apr-96	1	Insecta, Tendipedidae	Orthocladinae		2				2	0.009091	-0.018558	9601
10-Apr-96	1	Insecta, Tendipedidae	Polypedilum sp.	3		3		9	15	0.068182	-0.079523	9601
10-Apr-96	1	Insecta,	Procladius sp.			1		5	6	0.027273	-0.042662	9601

		Tendipedidae										
10-Apr-96	1	Insecta, Tendipedidae	Tanypodinae	2		1	2	3	8	0.036364	-0.052339	9601
10-Apr-96	1	Insecta, Tendipedidae	Tanypodini				1		1	0.004545	-0.010647	9601
10-Apr-96	1	Insecta, Tendipedidae	Tanypus sp.			1			1	0.004545	-0.010647	9601
10-Apr-96	1	Insecta, Tendipedidae	un id. Chironomid	1				2	3	0.013636	-0.025436	9601
10-Apr-96	1	Insecta	Ansioptera nymph				1		1	0.004545	-0.010647	9601
		No. taxa		12	8	8	12	12	20			
		No. specimens		47	28	26	44	75	220			
		Density, #/m2		23189	13815	12828	21709	37004	21709			
		Shannon-Weaver Diversity Index		2.019	1.765	1.298	1.946	2.262	0.036			
		Margalef's Species Richness		5.981	4.292	4.240	6.693	5.333	8.111			
10-Apr-96	2	Annelida, Oligochaeta	Chaetogaster sp.		1	3	1	2	7	0.013035	-0.024570	9601
10-Apr-96	2	Annelida, Oligochaeta	Dero digitata	6	2	5	3	45	61	0.113594	-0.107306	9601
10-Apr-96	2	Annelida, Oligochaeta	Styleria lacustri	3		3			6	0.011173	-0.021808	9601
10-Apr-96	2	Annelida, Oligochaeta	immature Limnodrilus		1				1	0.001862	-0.005084	9601
10-Apr-96	2	Crustacea, Cladocera	Cladocera	7	11	27	11	20	76	0.141527	-0.120179	9601
10-Apr-96	2	Crustacea, Copepoda, Cyclopoida	Cyclopodia copepods	2	4	7	18	18	49	0.091248	-0.094877	9601
10-Apr-96	2	Crustacea,	Harpacticoid	2	128	4	20		154	0.286778	-0.155564	9601

		Copepoda, Harpacticoida	copepod									
10-Apr-96	2	Crustacea, Copepoda, Harpacticoida	incysted Harpacticoid		40	5	21	94	160	0.297952	-0.156679	9601
10-Apr-96	2	Insecta, Tendipedidae	Chironomus pupa					1	1	0.001862	-0.005084	9601
10-Apr-96	2	Insecta, Tendipedidae	Chironomus sp.	1	1	1		5	8	0.014898	-0.027216	9601
10-Apr-96	2	Insecta, Tendipedidae	Polypedilum sp.			1		5	6	0.011173	-0.021808	9601
10-Apr-96	2	Insecta, Tendipedidae	Tanypodini	2				1	3	0.005587	-0.012586	9601
10-Apr-96	2	Insecta, Tendipedidae	un id. Chironomid				1	4	5	0.009311	-0.018911	9601
		No. taxa		7	8	9	7	10	13			
		No. specimens		23	188	56	75	195	537			
		Density, #/m2		11348	92756	27629	37004	96209	52989			
		Shannon-Weaver Diversity Index		1.752	0.999	1.723	1.577	1.512	0.772			
		Margalef's Species Richness		4.406	3.514	3.187	3.200	3.930	4.396			
10-Apr-96	4	Annelida, Oligochaeta	Chaetogaster sp.			5	1	1	7	0.041667	-0.057509	9601
10-Apr-96	4	Annelida, Oligochaeta	Dero digitata	8	5	9	2	5	29	0.172619	-0.131693	9601
10-Apr-96	4	Annelida, Oligochaeta	Styleria lacustri	4	2	2		1	9	0.053571	-0.068093	9601
10-Apr-96	4	Crustacea, Copepoda,	Cyclopodia copepods		27	73		3	103	0.613095	-0.130266	9601

		Cyclopoida										
10-Apr-96	4	Crustacea, Copepoda, Harpacticoida	Harpacticoid copepod	8			1		9	0.053571	-0.068093	9601
10-Apr-96	4	Insecta, Tendipedidae	Chironomus sp.	1		1		2	4	0.023810	-0.038649	9601
10-Apr-96	4	Insecta, Tendipedidae	Orthocladinae pupa			1			1	0.005952	-0.013246	9601
10-Apr-96	4	Insecta, Tendipedidae	Polypedilum sp.		1				1	0.005952	-0.013246	9601
10-Apr-96	4	Insecta, Tendipedidae	Procladius sp.		1				1	0.005952	-0.013246	9601
10-Apr-96	4	Insecta, Tendipedidae	Tanypus sp.		2	1			3	0.017857	-0.031218	9601
10-Apr-96	4	Insecta, Tendipedidae	un id. Chironomid		1				1	0.005952	-0.013246	9601
		No. taxa		4	7	7	3	5	11			
		No. specimens		21	39	92	4	12	168			
		Density, #/m2		10361	19242	45391	1974	5921	16578			
		Shannon-Weaver Diversity Index		1.055	1.194	0.800	1.040	1.424	0.579			
		Margalef's Species Richness		1.537	4.369	3.055	3.322	3.707	4.494			
25-Jun-96	2	Annelida, Oligochaeta	Dero digitata			2			2	0.008299	-0.017270	9602
25-Jun-96	2	Annelida, Oligochaeta	Styleria lacustri			1			1	0.004149	-0.009884	9602
25-Jun-96	2	Crustacea, Copepoda, Harpacticoida	incysted Harpacticoids	29	198				227	0.941909	-0.024481	9602

25-Jun-96	2	Insecta, Tendipedidae	Chironomus sp.			2	3	5	0.020747	-0.034918	9602
25-Jun-96	2	Insecta, Tendipedidae	Cladotanytarsus sp.	1				1	0.004149	-0.009884	9602
25-Jun-96	2	Insecta, Tendipedidae	Glypotendipes sp.	1				1	0.004149	-0.009884	9602
25-Jun-96	2	Insecta, Tendipedidae	Polypedilum sp.				1	1	0.004149	-0.009884	9602
25-Jun-96	2	Insecta, Tendipedidae	un id. Chironomid	1		1		2	0.008299	-0.017270	9602
25-Jun-96	2	Nematoda	Nematode			1		1	0.004149	-0.009884	9602
		No. taxa		4	1	5	2	9			
		No. specimens		32	198	7	4	241			
		Density, #/m2		15788	97689	3454	1974	29726			
		Shannon-Weaver Diversity Index		0.414	0.000	1.550	0.562	0.143			
		Margalef's Species Richness		1.993	0.000	4.733	1.661	3.358			
25-Jun-96	4	Crustacea, Copepoda, Cyclopoida	Cyclopodia copepod	1				1	0.004149	-0.009884	9602
25-Jun-96	4	Crustacea, Ostracoda	Ostracod	1				1	0.004149	-0.009884	9602
25-Jun-96	4	Insecta, Odonata	Zygoptera nymph				1	1	0.004149	-0.009884	9602
25-Jun-96	4	Insecta, Tendipedidae	un id. Chironomid	1				1	0.004149	-0.009884	9602
		No. taxa		3			1	4			
		No. specimens		3			1	4			
		Density, #/m2		1480			493	987			
		Shannon-Weaver		1.099			0.000	0.040			

		Diversity Index										
		Margalef's Species Richness		4.192			0.000		4.983			
10-Apr-97	1	Annelida, Oligochaeta	Chaetogaster				5		5	0.172414	-0.131626	9701
10-Apr-97	1	Insecta,	Chaoborus	2					2	0.068966	-0.080094	9701
10-Apr-97	1	Insecta, Chironomidae	Chironomus				1		1	0.034483	-0.050428	9701
10-Apr-97	1	Insecta, Chironomidae	Chironomids		1		16		17	0.586207	-0.135970	9701
10-Apr-97	1	Insecta, Tendipedidae	Coelotanypus				2		2	0.068966	-0.080094	9701
10-Apr-97	1	Mollusca, Gastropoda	Planorbid Snail	2					2	0.068966	-0.080094	9701
		No. taxa		2	1	0	4	0	6			
		No. specimens		4	1	0	24	0	29			
		Density, #/m2		1974	493	0	11841	0	2862			
		Shannon-Weaver Diversity Index		0.693	0.000	0.000	0.937	0.000	0.558			
		Margalef's Species Richness		0.000	0.000	0.000	2.174	0.000	3.419			
10-Apr-97	2	Annelida, Oligochaeta	Naidae					1	1	0.000151	-0.000578	9701
10-Apr-97	2	Annelida, Oligochaeta	Chaetogaster		1				1	0.000151	-0.000578	9701
10-Apr-97	2	Annelida, Oligochaete	Dero digitata				2	8	10	0.001513	-0.004266	9701
10-Apr-97	2	Crustacea,	Harpacticoids			25			25	0.003781	-0.009160	9701

		Copepoda, Harpacticoida										
10-Apr-97	2	Insecta, Culicidae	Chaoborus				1	1	2	0.000303	-0.001065	9701
10-Apr-97	2	Insecta, Chironomidae	Chironomids	3	2			5	10	0.001513	-0.004266	9701
10-Apr-97	2	Insecta, Chironomidae	Chironomus				1	1	2	0.000303	-0.001065	9701
10-Apr-97	2	Insecta, Tendipedidae	Coelotanypus				2	3	5	0.000756	-0.002361	9701
10-Apr-97	2	Insecta, Zygoptera	Zygopteran larvae		1		1		3	0.000454	-0.001517	9701
10-Apr-97	2	Mollusca, Gastropoda	Planorbid Snail		4		3	1	8	0.001210	-0.003530	9701
		No. taxa		1	4	1	6	7	10			
		No. specimens		3	8	25	10	20	67			
		Density, #/m2		1480	3947	12335	4934	9868	6611			
		Shannon-Weaver Diversity Index		0.000	1.226	0.000	1.696	1.597	0.028			
		Margalef's Species Richness		0.000	3.322	0.000	5.000	4.612	4.929			
10-Apr-97	3	Annelida, Oligochaete	Dero digitata	5		1	1	4	11	0.224490	-0.145650	9701
10-Apr-97	3	Insecta,	Chaoborus	1		1	2	2	6	0.122449	-0.111679	9701
10-Apr-97	3	Insecta, Chironomidae	Chironomids	8	7	4	7	6	32	0.653061	-0.120846	9701
		No. taxa		3	1	3	3	3	3			
		No. specimens		14	7	6	10	12	49			
		Density, #/m2		6907	3454	2960	4934	5921	4835			
		Shannon-Weaver Diversity Index		0.876	0.000	0.868	0.802	1.011	0.378			

		Margalef's Species Richness		1.745	0.000	2.570	2.000	1.853	1.183			
10-Apr-97	4	Annelida, Oligochaeta	Naidae		89	6	97		192	0.004140	-0.009865	9701
10-Apr-97	4	Annelida, Oligochaeta	Limnodrilus				1		1	0.000022	-0.000101	9701
10-Apr-97	4	Annelida, Oligochaete	Chaetogaster					4	4	0.000086	-0.000351	9701
10-Apr-97	4	Annelida, Oligochaete	Dero digitata	29	4	5	10	2	50	0.001078	-0.003199	9701
10-Apr-97	4	Insecta,	Ceratopongid	9	27	4	24		64	0.001380	-0.003947	9701
10-Apr-97	4	Insecta, Chironomidae	Chironomid pupae		3			12	15	0.000323	-0.001129	9701
10-Apr-97	4	Insecta, Chironomidae	Chironomids		2	1	4		7	0.000151	-0.000577	9701
10-Apr-97	4	Insecta, Chironomidae	Chironomus				3		3	0.000065	-0.000271	9701
10-Apr-97	4	Insecta, Culicidae	Acellus	4	27	16	40	1	88	0.001897	-0.005165	9701
10-Apr-97	4	Insecta, Tendipedidae	Coelotanypus					21	21	0.000453	-0.001514	9701
10-Apr-97	4	Insecta, Zygoptera	Zygopteran larvae					1	1	0.000022	-0.000101	9701
10-Apr-97	4	Mollusca, Gastropoda	Dextro snail		1		1		2	0.000043	-0.000188	9701
10-Apr-97	4	Mollusca, Gastropoda	Physa	1		1			2	0.000043	-0.000188	9701
10-Apr-97	4	Mollusca, Gastropoda	Planorbid Snail		1		1	4	6	0.000129	-0.000503	9701
10-Apr-97	4	Mollusca, Pelecypoda	Pisidium				1	13	14	0.000302	-0.001063	9701

		No. taxa		4	8	6	10	8	15			
		No. specimens		43	154	33	182	58	470			
		Density, #/m2		21215	75981	16282	89795	28616	46378			
		Shannon-Weaver Diversity Index		0.901	1.221	1.415	1.361	1.654	0.028			
		Margalef's Species Richness		1.837	3.200	3.292	3.982	3.970	5.239			
16-Oct-97	2	Annelida, Oligochaete	Dero digitata		1	1	1	1	4	0.500000	-0.150515	9702
16-Oct-97	2	Insecta, Chironomidae	Chironomids				1	2	3	0.375000	-0.159738	9702
16-Oct-97	2	Mollusca, Gastropoda	Planorbid Snail			1			1	0.125000	-0.112886	9702
		No. taxa		0	1	2	2	2	3			
		No. specimens		0	1	2	2	3	8			
		Density, #/m2		0	493	987	987	1480	789			
		Shannon-Weaver Diversity Index		0.000	0.000	0.693	0.693	0.637	0.423			
		Margalef's Species Richness		0.000	0.000	3.322	3.322	2.096	2.215			
16-Oct-97	3	Annelida, Oligochaeta	Naidae		1				1	0.016393	-0.029268	9702
16-Oct-97	3	Annelida, Oligochaete	Dero digitata	10		3		3	16	0.262295	-0.152448	9702
16-Oct-97	3	Coelenterata, Hydrozoa	Hydra	1					1	0.016393	-0.029268	9702
16-Oct-97	3	Insecta,	Chaoborus	5	6	16	2	2	31	0.508197	-0.149394	9702
16-Oct-97	3	Insecta,	Chironomids	6	1	1	1	2	11	0.180328	-0.134153	9702

		Chironomidae											
16-Oct-97	3	Insecta, Chironomidae	Chironomus			1			1	0.016393	-0.029268	9702
		No. taxa		4	3	4	2	3	6			
		No. specimens		22	8	21	3	7	61			
		Density, #/m2		10854	3947	10361	1480	3454	6019			
		Shannon-Weaver Diversity Index		1.190	0.736	0.775	0.637	1.079	0.524			
		Margalef's Species Richness		2.235	2.215	2.269	2.096	2.367	2.801			
16-Oct-97	4	Annelida, Oligochaeta	Eristalis	2	1	2	4	1	10	0.046296	-0.061780	9702
16-Oct-97	4	Annelida, Oligochaeta	Styleria			4			4	0.018519	-0.032081	9702
16-Oct-97	4	Annelida, Oligochaeta	Limnodrilus		8	2		1	11	0.050926	-0.065850	9702
16-Oct-97	4	Annelida, Oligochaeta	Ilyodrilus		6	3	1		10	0.046296	-0.061780	9702
16-Oct-97	4	Annelida, Oligochaeta	Naidae	15	8		3	6	32	0.148148	-0.122860	9702
16-Oct-97	4	Annelida, Oligochaete	Dero digitata					4	4	0.018519	-0.032081	9702
16-Oct-97	4	Crustacea, Gammariidae	Gammarus		1		1		2	0.009259	-0.018828	9702
16-Oct-97	4	Insecta, Zygoptera	Zygopteran larva	1		1	1		3	0.013889	-0.025796	9702
16-Oct-97	4	Insecta,	Ceratopongid	2	13		1		16	0.074074	-0.083728	9702
16-Oct-97	4	Insecta, Chironomidae	Chironomids	1			1		2	0.009259	-0.018828	9702
16-Oct-97	4	Insecta, Culicidae	Acellus	14	18	9	20	21	82	0.379630	-0.159687	9702

16-Oct-97	4	Mollusca, Gastropoda	Physa	1		1		6	8	0.037037	-0.053013	9702
16-Oct-97	4	Mollusca, Gastropoda	Planorbid Snail	9		1			10	0.046296	-0.061780	9702
16-Oct-97	4	Mollusca, Pelecypoda	Pisidium	1	1			2	4	0.018519	-0.032081	9702
16-Oct-97	4	Platyhelminthes, Tricladida	Triclad	11	2	4			17	0.078704	-0.086889	9702
16-Oct-97	4	Vertebrata, Pisces, Poeciliidae	Gambusia					1	1	0.004630	-0.010808	9702
		No. taxa		10	9	9	8	8	16			
		No. specimens		57	58	27	32	42	216			
		Density, #/m2		28123	28616	13321	15788	20722	21314			
		Shannon-Weaver Diversity Index		1.824	1.806	1.928	1.317	1.538	0.928			
		Margalef's Species Richness		5.126	4.537	5.589	4.651	4.312	6.425			
13-Apr-98	1	Annelida, Oligochaete	Naidae				2		2	0.013333	-0.025001	9801
13-Apr-98	1	Crustacea, Copepoda, Cyclopoida	Cyclopods	3	2		7		12	0.080000	-0.087753	9801
13-Apr-98	1	Crustacea, Copepoda, Harpacticoida	Harpacticoids	36	25	13	36	12	122	0.813333	-0.072982	9801
13-Apr-98	1	Insecta, Chironomidae	Chironomids	11			1		12	0.080000	-0.087753	9801
13-Apr-98	1	Insecta, Culicidae	Culicid				1		1	0.006667	-0.014507	9801
13-Apr-98	1	Insecta, Tanytarsini	Tanytarsini		1				1	0.006667	-0.014507	9801

		No. taxa		3	3	1	5	1	6			
		No. specimens		50	28	13	47	12	150			
		Density, #/m2		24669	13815	6414	23189	5921	14801			
		Shannon-Weaver Diversity Index		0.738	0.409	0.000	0.786	0.000	0.303			
		Margalef's Species Richness		1.177	1.382	0.000	2.392	0.000	2.298			
13-Apr-98	2	Annelida, Oligochaeta	Stylaria				1		1	0.001274	-0.003688	9801
13-Apr-98	2	Crustacea, Copepoda, Cyclopoida	Cyclopods		2		2		4	0.005096	-0.011683	9801
13-Apr-98	2	Crustacea, Copepoda, Harpacticoida	Harpacticoids	256	34	186	207	74	757	0.964331	-0.015211	9801
13-Apr-98	2	Insecta, Ceratopongonidae	Ceratopongonid			1			1	0.001274	-0.003688	9801
13-Apr-98	2	Insecta, Chironomidae	Chironomids	2	5	2	4	2	15	0.019108	-0.032843	9801
13-Apr-98	2	Insecta, Tanytarsini	Tanytarsini		2		2		4	0.005096	-0.011683	9801
13-Apr-98	2	Nematoda	Nematode					1	3	0.003822	-0.009240	9801
		No. taxa		2	4	3	5	3	7			
		No. specimens		258	43	189	216	77	785			
		Density, #/m2		127292	21215	93249	106570	37990	77461			
		Shannon-Weaver Diversity Index		0.045	0.721	0.092	0.226	0.189	0.088			
		Margalef's Species Richness		0.415	1.837	0.879	3.855	1.06	2.073			

13-Apr-98	3	Annelida, Oligochaete	Dero digitata	31					31	0.105085	-0.102821	9801
13-Apr-98	3	Annelida, Oligochaete	Dero sp		23	4	3	7	37	0.125424	-0.113085	9801
13-Apr-98	3	Annelida, Oligochaete	Naidae	19	47		5	4	75	0.254237	-0.151210	9801
13-Apr-98	3	Crustacea, Cladocera	Cladoceran	15	18	5	18	13	69	0.233898	-0.147583	9801
13-Apr-98	3	Crustacea, Copepoda, Cyclopoida	Cyclopods					1	1	0.003390	-0.008372	9801
13-Apr-98	3	Insecta, Ansiopteridae	Ansiopteran nymph				1		1	0.003390	-0.008372	9801
13-Apr-98	3	Insecta, Chironomidae	Chironomid pupae		1			1	2	0.006780	-0.014704	9801
13-Apr-98	3	Insecta, Chironomidae	Chironomids	6					6	0.020339	-0.034407	9801
13-Apr-98	3	Insecta, Chironomidae	Chironomus	3	3		3	2	11	0.037288	-0.053263	9801
13-Apr-98	3	Insecta, Coleoptera	Coleopteran larva					1	1	0.003390	-0.008372	9801
13-Apr-98	3	Insecta, Tanypodinidae	Tanypodinid	1					1	0.003390	-0.008372	9801
13-Apr-98	3	Invertebrata	Unidentified	2	33	0	5	16	56	0.189831	-0.136988	9801
13-Apr-98	3	Mollusca, Gastropoda	Planorbid Snail	2			1		3	0.010169	-0.020265	9801
13-Apr-98	3	Mollusca, Gastropoda	Snail		1				1	0.003390	-0.008372	9801
		No. taxa		8	7	3	7	8	14			
		No. specimens		79	126	9	36	45	295			
		Density, #/m2		38977	62166	4440	17762	22202	29109			
		Shannon-Weaver		1.587	1.473	0.687	1.508	1.623	0.816			

		Diversity Index											
		Margalef's Species Richness		3.689	2.857	1.048	3.855	4.234	5.264				
13-Apr-98	4	Annelida, Oligochaeta	Dero sp		2			4	6	0.063830	-0.076275	9801
13-Apr-98	4	Annelida, Oligochaeta	Tubificidae	1	21	17	9		48	0.510638	-0.149048	9801
13-Apr-98	4	Crustacea, Isopoda	Isopod	4	5	1	4	3	17	0.180851	-0.134314	9801
13-Apr-98	4	Insecta,	Unidentified				1		1	0.010638	-0.020991	9801
13-Apr-98	4	Mollusca, Pelecypoda	Unidentified	8	2		8	1	19	0.202128	-0.140352	9801
13-Apr-98	4	Nematoda	Nematode			2	1		3	0.031915	-0.047745	9801
		No. taxa		3	4	3	5	3	6			
		No. specimens		13	30	20	23	8	94			
		Density, #/m2		6414	14801	9868	11348	3947	9276			
		Shannon-Weaver Diversity Index		0.859	0.909	0.518	1.311	0.974	0.569			
		Margalef's Species Richness		1.795	2.031	1.537	2.937	2.215	2.534			